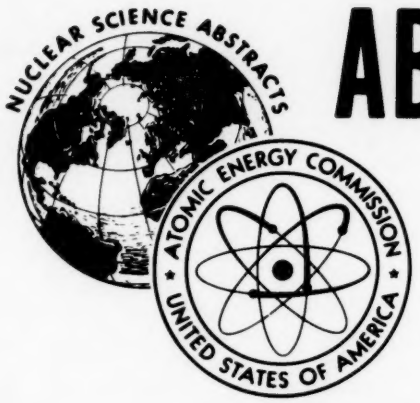
NUCLEAR SCIENCE ABSTRACTS



Volume 26 Number 10

Abstracts 22549-25131

May 31, 1972

UNITED STATES ATOMIC ENERGY COMMISSION

REPORT COLLECTIONS IN THE UNITED STATES

The libraries listed below purchase and maintain microfiche collections of USAEC and foreign reports that are abstracted in *NSA*. Their collections also include *NSA* and its indexes, AEC's Technical Progress Reviews, AEC-sponsored translations, conference proceedings published by AEC, and various bibliographic tools. Most of these libraries have microfiche reader-printers or other photocopy facilities with which to reproduce enlarged copies from microfiche. Charges for reproduction services vary.

ALABAMA
Auburn, Auburn University
Tuskegee Institute, Tuskegee Institute

ALASKA
College, University of Alaska

ARIZONA
Tucson, University of Arizona

CALIFORNIA
Davis, University of California
Los Angeles, University of California
Santa Barbara, University of California

COLORADO
Boulder, University of Colorado

DISTRICT OF COLUMBIA
Washington, Library of Congress

FLORIDA
Gainesville, University of Florida

GEORGIA
Atlanta, Georgia Institute of Technology

HAWAII
Honolulu, University of Hawaii

IDAHO
Pocatello, Idaho State University

ILLINOIS
Urbana, University of Illinois

INDIANA
Lafayette, Purdue University

IOWA
Ames, Iowa State University

KANSAS
Manhattan, Kansas State University

KENTUCKY
Lexington, University of Kentucky
Louisville, University of Louisville

MARYLAND
Baltimore, Johns Hopkins University
College Park, University of Maryland

MASSACHUSETTS
Cambridge, Massachusetts Institute of Technology
Worcester, Worcester Polytechnic Institute

MICHIGAN
Ann Arbor, University of Michigan

MISSISSIPPI
State College, Mississippi State University

MISSOURI
Columbia, University of Missouri
Kansas City, Linda Hall Library

NEW JERSEY
Princeton, Princeton University

NEW MEXICO
Albuquerque, University of New Mexico

NEW YORK
Albany, New York State Library
Albany, State University at Albany
Ithaca, Cornell University
New York, Columbia University
Rochester, University of Rochester
Syracuse, Syracuse University
Troy, Rensselaer Polytechnic Institute

NORTH CAROLINA
Raleigh, North Carolina State University

OHIO
Cincinnati, University of Cincinnati
Cleveland, Cleveland Public Library

OHIO (Continued)
Columbus, Ohio State University
Toledo, University of Toledo

OKLAHOMA
Norman, University of Oklahoma

PENNSYLVANIA
Philadelphia, University of Pennsylvania
Pittsburgh, Carnegie Library
University Park, Pennsylvania State University

PUERTO RICO
San Juan, University of Puerto Rico

SOUTH CAROLINA
Columbia, University of South Carolina

TENNESSEE
Knoxville, University of Tennessee
Nashville, Joint University Libraries

TEXAS
Austin, University of Texas
College Station, Texas A & M University
Houston, Rice University

UTAH
Salt Lake City, University of Utah

VIRGINIA
Blacksburg, Virginia Polytechnic Institute
Charlottesville, University of Virginia

WASHINGTON
Pullman, Washington State University
Seattle, University of Washington

WEST VIRGINIA
Morgantown, West Virginia University

WISCONSIN
Madison, University of Wisconsin

The following governmental and international organizations offer for sale USAEC reports abstracted in *Nuclear Science Abstracts*:

National Technical Information Service, U. S. Department of Commerce
Springfield, Virginia 22151
International Atomic Energy Agency, Vienna, Austria
National Lending Library, Boston Spa, England

Volume 26, Number 10, May 31, 1972

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Office of Information Services, John A. Harris, Director. Published by the USAEC Technical Information Center, Robert L. Shannon, Manager.

Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of international nuclear science literature. *Nuclear Science Abstracts* covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

The following organizations scan and abstract the nuclear science literature in their respective countries:

Atomic Energy of Canada Limited
Australian Atomic Energy Commission
Danish Atomic Energy Commission
Finnish Atomic Energy Commission
French Atomic Energy Commission
Japan Atomic Energy Bureau–Atomic Energy Research Institute
Institutt for Atomenergi (Norway)
Aktiebolaget Atomenergi (Sweden)
United Kingdom Atomic Energy Authority

Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications, e.g., in the United States the American Institute of Physics provides page-proof copy of its publications.

A list of the journals scanned regularly and the abbreviations used appears in Issue 1 (January 15) of each volume of *Nuclear Science Abstracts* and is supplemented in Issues 7, 13, and 19. Issue 1 of each volume also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

AVAILABILITY OF PUBLICATIONS ABSTRACTED

Public availability of all U. S. Atomic Energy Commission reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations abstracted in *Dissertation Abstracts International, Part B* and included in *Nuclear Science Abstracts* are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan 48103.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

HOW TO OBTAIN NUCLEAR SCIENCE ABSTRACTS

Nuclear Science Abstracts is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

For the 24 regular issues, the yearly rate is $42.00 for domestic subscribers and $52.50 for foreign subscribers. A single issue costs $1.75, domestic rates, or $2.19, foreign rates. Domestic rates apply to the United States, Canada, Mexico, and Central and South American countries except Argentina, Brazil, Guyana, French Guiana, Surinam, and British Honduras.

For a yearly subscription to the cumulative indexes, the rates are $34.50 for domestic subscribers and $43.00 for foreign subscribers.

The following cumulative indexes are available:

From Johnson Reprint Corporation, 111 Fifth Avenue, New York, N. Y. 10003:
Vols. 1–4, Subjects and Authors (1948–1950), $30.00.

From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402:

Vols. 5–10, Subjects and Authors (1951–1956), $5.25.

Vols. 11–15, Subjects (1957–1961), $19.00.
Vols. 11–15, Personal Authors (1957–1961), $14.25.
Vols. 11–15, Corporate Authors (1957–1961), $2.50.

Vols. 16–20, Subjects (1962–1966), $36.00.
Vols. 16–20, Personal Authors (1962–1966), $22.50.
Vols. 16–20, Corporate Authors (1962–1966), $3.75.

Vol. 21, Subjects and Authors (1967), $16.00.
Vol. 22, Subjects and Authors (1968), $26.00.
Vol. 23, Subjects and Authors (1969), $25.75.
Vol. 24, Subjects and Authors (1970), $22.50.
Vol. 24, Authors (1970), Suppl., $2.00.
Vol. 25, Subjects and Authors (1971), $27.50.

Cumulative Report Number Index, Vols. 1–15 Revised, $4.00.
Cumulative Report Number Index, Vols. 16–20 Revised, $5.50.
Cumulative Report Number Index, Vols. 21–25, $5.75.

Nuclear Science Abstracts is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Government agencies may obtain *NSA* free of charge. Inquiries should be directed to the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

Nuclear Science Abstracts is also available on 16-mm and 35-mm microfilm in reel or cartridge from Princeton Microfilm Corporation, Alexander Road, Princeton, New Jersey 08540. The cost of Vols. 1–24 (1948–1970) including *Abstracts of Declassified Documents* (1947–1948) is $625.20. The indexes for *Nuclear Science Abstracts* Vols. 1–24 (1948–1970) are also available for $320.00. The cost of each volume (one calendar year) of *NSA* and its indexes, including that for the year 1971, is $95.

INDEXES TO NSA

Comprehensive indexes appear in each issue and are cumulated quarterly and annually. Multivolume cumulations have been issued as indicated above.

All documents abstracted are indexed by subjects and personal authors. Report literature is indexed also by corporate author and report number. Each of these indexes in every issue is preceded by an introduction explaining in detail the organization of the index and the principles by which it is compiled. The reader is referred to these explanations for information not found in the brief summary below.

Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

```
NEWCOMB, William A., Stability of a magnetic well,  25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary
    alloys V3Si--Nb3Al,  25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage,  25:140
    (AAEC/LIB/Bib-254)
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

```
TRANSURANIUM ELEMENTS
  determination in bone ash, radiochemical method for,
    25:40 (IDO-12073, pp 28-36)
  separation by ion exchange and complex-formation elution,
    25:251(P)

TRIETHYLENETETRAMINE
  complexes with cobalt(III) and rhodium(III) chlorides,
    radiation effects on labeled, thermal-neutron,  25:137
TRITIUM
  content in Cattaraugus Creek near West Valley Processing
    Plant, July through Dec. 1969,  25:258 (DOCKET-50201-
    48)
  content in Cattaraugus Creek near West Valley Processing
    Plant, Jan. to July 1970,  25:259 (DOCKET-50201-49)
  determination in luminescent material by scintillation
    counting,  25:40 (IDO-12073, pp 28-36)
```

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

is indexed as:

```
CALIFORNIA UNIV., LIVERMORE.  LAWRENCE RADIATION LAB.
  Construction of a unique underground whole body counter,
    25:372 (UCRL-72739)
```

Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

```
ORNL-
  4270(Vol.2)  25-614    Dep. NTIS
  4606         25-1530   Dep. NTIS

ORNL-IBP-
  70-3         25-2025   Dep. NTIS

ORNL-IIC-
  21           25-261    Dep. NTIS
  30(Pt.2)     25-331    Dep. NTIS

ORNL-NSIC-
  78           25-1912   Dep. NTIS
```

TABLE OF CONTENTS

Volume 26, Number 10, May 31, 1972

Category	Page
CHEMISTRY	2147
Analytical Chemistry	2147
Activation and Nuclear Reaction Procedures	2147
Chemical and Spectral Procedures	2149
Radiometric and Radiochemical Procedures	2150
Separation Procedures	2150
Inorganic, Organic, and Physical Chemistry	2151
Chemical and Physical-Chemical Properties	2152
Isotope Effects	2152
Isotope Exchange and Isotope Separation	2154
Radiation Chemistry	2154
Radiochemistry and Nuclear Chemistry	2158
Hot-Atom Chemistry	2158
Properties of Radioactive Materials	2158
Radioactive Waste Treatment	2161
Radioisotope Production	2161
Reactor Fuel Reprocessing	2161
ENGINEERING	2163
Energy Conversion	2163
Facilities and Equipment	2164
Heat Transfer and Fluid Flow	2165
Materials Testing	2166
Nuclear Explosions	2167
Detection Systems	2168
Civil Uses	2168
Protective Structures and Equipment	2168
Safety Engineering	2169
Vacuum Engineering	2170
ENVIRONMENTAL AND EARTH SCIENCES	2171
Minerals and Ores	2171
Radioactive Effluents	2172
Radioactivity Transport and Monitoring	2172
Atmosphere	2173
Soil	2174
Water	2174
Ecosystems and Food Cycles	2175
Radiometric Techniques	2176
Site Surveys	2176
Thermal Effluents	2177
INSTRUMENTATION	2178
Radiation Detection Instruments	2178
General Detectors and Monitors	2178
Radiation Dosimeters	2181
Nuclear Spectroscopic Instrumentation	2182
High Energy Physics Instrumentation	2184
Radiometric Instruments	2184
Radiation Effects on Instrument Components, Instruments, and Electronic Systems	2185
Miscellaneous Instruments and Components	2186
ISOTOPE AND RADIATION SOURCE TECHNOLOGY	2188
Isotope Separation (Industrial)	2188
Isotopic Power Sources	2189
Radiation Sources	2189
Design and Fabrication	2190
Industrial Uses	2190
LIFE SCIENCES	2193
Radiation Effects on Biochemicals (External Source)	2193
Radiation Effects on Cultured Cells (External Source)	2194
Radiation Effects on Microorganisms (External Source)	2197
Radiation Effects on Plants (External Source)	2200
Radiation Effects on Animals (External Source)	2203
Man	2203
Vertebrates	2207
Invertebrates	2213
Radionuclide Effects (Internal Source)	2216
Man	2216
Animals	2217
Plants	2218
Microorganisms	2218
Nuclide Kinetics and Toxicology	2218
Man	2218
Animals	2219
Plants	2221
New Tracer Techniques	2221
MATERIALS	2223
Ceramics and Cermets	2223
Metals and Alloys	2228
Corrosion and Erosion	2229
Preparation and Fabrication	2230
Properties, Structure, and Phase Studies	2233
Radiation Effects	2240
Other Materials	2242
NUCLEAR MATERIALS AND WASTE MANAGEMENT	2244
Accountability and Safeguards	2244
Disposal and Storage	2244
Handling Equipment and Procedures	2245
Transportation	2245
PARTICLE ACCELERATORS	2247
Design, Development, and Operation	2247
Auxiliaries and Components	2247
Ion Sources, Injection, and Extraction	2247
Ion Optics and Field Calculations	2248
Storage Rings	2248
Experimental Facilities	2248
PHYSICS (ASTROPHYSICS AND COSMOLOGY)	2249
Cosmic Radiation	2249
Stars	2250
Quasi-Stellar, Radio, and X-Ray Sources	2255
Solar Phenomena	2258
Galaxies	2263
Cosmology	2265
Planetary Phenomena	2266
PHYSICS (ATMOSPHERIC)	2267
Auroral and Ionospheric Phenomena	2267
Particle Kinetics and Trapping	2269

TABLE OF CONTENTS (continued)

Category	Page
PHYSICS (ATOMIC AND MOLECULAR)	2270
Atomic, Electron, Ion, and Molecular Beams and Their Reactions	2270
Atomic and Molecular Properties	2270
Positronium, Muonium, and Mesic Atoms and Molecules	2273
Collision Phenomena	2273
Atomic Theory	2277
PHYSICS (ELECTROFLUID AND MAGNETOFLUID)	2280
PHYSICS (HIGH-ENERGY)	2281
Particle Interactions and Properties (Experimental)	2281
Electromagnetic	2281
Weak	2281
Strong (Baryon-induced)	2282
Strong (Meson-induced)	2283
Particle Interactions and Properties (Theoretical)	2284
General	2284
Electromagnetic	2286
Weak	2289
Strong (General)	2291
Strong (Baryon No. = 0)	2292
Strong (Baryon No. = 1)	2293
Strong (Baryon No. > 2)	2294
Particle Invariance Principles and Symmetries	2295
General	2295
Applications (Electromagnetic and Weak)	2296
Applications (Strong)	2296
Field Theories	2296
General	2296
Quantum Field Theory	2296
Gravitation and General Relativity	2298
Scattering Theory	2299
PHYSICS (LOW-TEMPERATURE)	2301
Superfluidity	2301
Superconductivity	2304
Equipment and Devices	2319
PHYSICS (NUCLEAR)	2320
Neutron Interactions with Matter	2320
Nuclear Properties and Reactions, $A < 5$	2320
Nuclear Properties and Reactions, $6 < A < 19$	2321
Nuclear Properties and Reactions, $20 < A < 38$	2323
Nuclear Properties and Reactions, $39 < A < 58$	2323
Nuclear Properties and Reactions, $59 < A < 89$	2325
Nuclear Properties and Reactions, $90 < A < 149$	2326
Nuclear Properties and Reactions, $150 < A < 189$	2328
Nuclear Properties and Reactions, $190 < A < 219$	2330
Nuclear Properties and Reactions, $A > 220$	2330
Nuclear Theory	2333
PHYSICS (PLASMA AND THERMONUCLEAR)	2337
Confinement and Heating	2337
Diagnostics	2341
Kinetics (General)	2343
Kinetics (Experimental)	2343
Kinetics (Theoretical)	2344
Production	2346
Stability	2347
Thermonuclear Processes	2350
Wave Phenomena	2352

Category	Page
PHYSICS (RADIATION AND SHIELDING)	2359
Radiation Physics	2359
Radiation Protection Standards	2361
Radiation Source Calibration and Standardization	2361
Shielding Calculations and Theory	2361
PHYSICS (SOLID-STATE)	2362
Radiation Effects	2362
Physical Properties	2364
Moessbauer Effects and NMR	2366
PHYSICS (THEORETICAL)	2368
REACTOR TECHNOLOGY	2370
Power Reactor Development	2370
Physics and Core Engineering	2371
Control and Instrumentation	2373
Containment Systems, Waste Processing, and Radiation Protection	2373
Coolant System	2374
Fuels and Fuel Elements	2375
Auxiliary Systems and Engineered Safeguards	2375
Operation and Economics	2375
Safety and Siting	2376
Steam and Power Conversion System	2377
Commercial Power Reactors	2378
Control and Instrumentation	2378
Operation and Economics	2379
Safety and Siting	2380
Propulsion and Auxiliary Power Reactors	2382
Control and Instrumentation	2383
Safety	2383
Process Heat and Desalination Reactors	2383
Operation and Economics	2384
Safety and Siting	2384
Research and Test Reactors	2384
Control and Instrumentation	2386
Operation and Economics	2387
Safety and Siting	2387
Reactor Components, Fuels, and Accessories	2388
Reactor Physics and Core Engineering	2390
Physics	2390
Core Thermal Hydraulics	2392
GENERAL	2393
Civilian Defense	2393
Law	2393
Miscellaneous	2393
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-11
SUBJECT INDEX	INDEX-67
REPORT NUMBER INDEX	INDEX-157

STAFF OF NUCLEAR SCIENCE ABSTRACTS

John W. Norris
Managing Editor

Donald D. Davis
Assistant Managing Editor

David E. Bost
Production Manager

Sidney F. Lanier
Subject Heading Specialist

J. Paul Meredith
Descriptive Cataloging Specialist

Frederick E. Marsh, Jr.
Computer Index Coordinator

Clara L. Fox
Corporate Author Specialist

Helen W. White
Report Number Specialist

Section Editors

Donald D. Davis
Life Sciences

Everett J. Hoffman
Chemistry

James M. Jacobs
Reactor Technology

Robert C. Kelly
Engineering; Environmental and Earth Sciences; Isotope and Radiation Source Technology; Materials; Nuclear Materials and Waste Management

Charles E. Stuber
Instrumentation; Particle Accelerators; High Energy Physics; Theoretical Physics

Lee M. Thompson
Astrophysics and Cosmology; Atmospheric Physics; Atomic and Molecular Physics; Electrofluid and Magnetofluid Physics; Low Temperature Physics; Plasma and Thermonuclear Physics; Radiation and Shielding Physics; Solid State Physics

Lawrence T. Whitehead
Nuclear Physics

Evaluators

Thomas S. Chapman
John H. Mitchell
Mary H. Newman
Polly C. Summers

Abstractors

Ellis R. Bedford
Jane G. Buchanan
D. Lamar Cason
David C. Cunningham
Theodore F. Davis
James R. Dulaney
Helga B. Gerstner
Mary C. Grissom
Phyllis C. Hansen
Carolyn D. Houston
W. Hugh Kinser, Jr.
Lisbeth C. Lieberman
William D. Matheny
Dora H. Moneyhun
Jean F. Peckham
Henry D. Raleigh
Mona H. Raridon
Julia S. Redford
Jessie W. Rushing
Robert W. Rutkowski
Francis L. Sachs
Lila B. Smith
Anne G. Ward
Helen L. Ward
Kenneth S. Warren
Milton O. Whitson
Juanita Wilson

Charles R. Bruce
Publishing Coordinator

Communication concerning the editorial policy and content of *Nuclear Science Abstracts* should be addressed to the Managing Editor, *Nuclear Science Abstracts*, USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 26, 1969.

Volume 26, Number 10 May 31, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 22600, 22938, and 24796.

22549 CLEAN LABORATORY FOR MINERALOGICAL AND GEOCHEMICAL STUDIES. Duke, Michael B.; Commeau, Robert F. U. S., Geol. Surv., Prof. Pap.; No. 750-B, 207-10(1971).

A class-100 (less than 100 particles per cubic foot of air) laminar-flow clean room has been built for mineralogical analyses that must exclude atmospheric particulate contamination. The room is kept clean in two basic ways: (1) air in the room is continuously recycled through high-efficiency particulate air filters, and (2) laminar airflow is maintained so that particles do not settle on material being worked on. The laboratory is used for special problems such as mineralogical studies of lunar soil. (auth)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 22689 and 23301.

22550 (IRI-133-71-5) AUTOMATED SEPARATIONS IN ROUTINE ACTIVATION ANALYSIS OF MERCURY. de Goeij, J. J. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). [1971]. 10p. (CONF-710626-1). Dep. NTIS (U. S. Sales Only).

From Meeting of the electron microscopy and analysis group; Cambridge, England (29 Jun 1971).

A method of chemical separation for use in connection with activation analysis for mercury was developed. Quartz vials containing mercury samples are irradiated, cooled, broken, and the contents decomposed and volatilized. The mercury is trapped in a sodium acetate solution, the droplets collected and dissolved in HNO_3 and counted. An automated instrument was devised for carrying out the destruction, oxidation, and distillation of the irradiated samples. The procedure was applied to the analysis of sediments; tissues of mammals, birds and fishes; biological fluids; human hair; foodstuffs, industrial products, and pharmaceuticals; plants and water. (J.G.B.)

22551 (SC-RR-710877) NEUTRON ACTIVATION ANALYSIS: SAMPLE PREPARATION UTILIZING GRAPHITE AS A DILUENT. Stalnaker, Nelson D.; Kahn, Milton; Kenna, Bernard T. (Sandia Labs., Albuquerque, N. Mex.). Aug 1971. 213p. Dep. NTIS.

Utilizing graphite as a diluent, sample preparation methods, which allow the preparation of standard and unknown samples that are of similar size, shape, composition and density, were developed for fast and thermal neutron activation analysis. The procedures developed were tested by determining the nitrogen content in several compounds by fast neutron activation analysis and by determining the copper content of various compounds by thermal neutron activation analysis. The nitrogen analyses generally agreed with Kjeldahl analyses within 5%, and the copper determinations usually agreed to less than 1% with thiosulfate determinations. The methods developed for fast neutron activation analysis employed 0.1 to 1.5 g of powdered sample compound. The methods developed for thermal neutron activation analysis employed mg quantities of sample compound, and it was necessary to put the compounds into solution to prevent loss of the compounds to the mixing vial walls. The solutions were deposited on the graphite and dried before mixing. The accuracy in both cases approached the statistical counting error. (auth)

22552 MICRODETERMINATION OF IODINE IN [BI-p-IODOPHENYLALANINE] INSULIN BY NEUTRON ACTIVATION ANALYSIS. Petri, H.; Erdtmann, G. (Kernforschungsanlage, Juelich, Ger.). Radiochem. Radioanal. Lett.; 9: No. 4, 309-14(4 Mar 1972).

For the determination of 5 μg iodine in 200 to 800 μg samples of [bi-p-iodophenylalanine] insulin, the samples were irradiated for 5 min at a neutron flux of 2×10^{13} $ncm^{-2}sec^{-1}$ and measured on a γ spectrometer for about 10 min. The minimum detectable amount may be lowered if the irradiation time and the counting time are increased and if nonactivable irradiation containers are used. The interference by zinc is smaller than 0.1%. This method seems to be very suitable for the routine control of iodine doted insulin and other complex organic compounds. (auth)

22553 RARE-EARTH ELEMENTS IN THE STEENS MOUNTAIN BASALTS. Helmke, Philip August. Madison, Wis.; Univ. of Wisconsin (1971). 171p. University Microfilms Order No. 71-28,990.

Thesis.

A procedure for analysis of 12 of the rare earth elements by neutron activation analysis is described in detail. The concentrations of the rare earth elements are given for 11 samples from a single Icelandic lava flow and for 52 of 70 consecutive lava flows from Steens Mountain, Oregon. For the single flow, the concentrations of the rare earth elements vary to the extent that the standard deviations from their mean values are about ±10%. The ratios between any two rare earth elements vary such that the standard deviations from the mean values are about 5%. The variance is caused by slight segregation of residual liquid from crystals during crystallization. The ranges in concentrations of the rare earth elements in the Steens Mountain basalts are much greater than those of the single lava flow. The lowest concentrations occur in the samples having the greatest contents of plagioclase phenocrysts. Eu is unusually abundant in those samples. They are interpreted as being plagioclase cumulates. The lava flows having the greatest concentrations of the rare earth elements also have unusually high concentration ratios of La to Sm and Sm to Eu. Those samples are interpreted as chilled residual liquids produced by fractional crystallization. Detail model studies of fractional crystallization and partial melting were made. The results indicate that the individual lava flows are compositionally related to each other in being derived from a common parent liquid by fractional crystallization processes. Effects of partial melting, however, cannot be rigorously excluded. The solid, derived phase that must be formed during fractional crystallization contains plagioclase, aluminous clinopyroxene, olivine and opaques. It has elemental abundances, including those of the rare earth elements, that are similar to those of many gabbros. The extent of crystallization is estimated from the concentrations of La. It is usually less than about 60%. The required values of the distribution coefficients for the rare earth elements in the various mineral phases of the derived material are similar to those in the literature. The concentrations of the rare earth elements in the basalts are probably too high to have been generated in a single episode of partial melting of a parent material with rare earth element concentrations equal to those of chondrites. The basalts can be produced if the source material has relative abundances of the rare earth elements that are similar to those of chondrites of oceanic tholeiites. Garnet and plagioclase are then almost totally excluded from the residual phase. (Diss. Abstr. Int., B)

22554 TRAINING REACTOR OF THE BUDAPEST POLYTECHNICAL UNIVERSITY AND THE POSSIBILITIES OF ITS USE IN ACTIVATION ANALYSIS. Csom, Gy.; Kecemley, G.; Kocsis, E. (Budapesti MueszakiEgyetem Egyetemi Atomreaktora). Izotoptechnika; 14: No. 12, 555-66(Dec 1971). (In Hungarian).

Reactor structure and its use in university training and research are described. (auth)

22555 NEUTRON ACTIVATION ANALYSIS WITH A PERIODICALLY PULSED REACTOR. Bogancs, J. (MTA Koezponti Fizikai Kutato Intezet, Budapest).; Csoke, A.; Nagy, A.; (and others). Izotoptechnika; 14: No. 11, 493-511(Nov 1971). In Hungarian).

The main characteristics of analytical methods using a periodically pulsed reactor are discussed. Advantages of neutron-selective irradiation, neutron capture, and short-lived species for activation analysis are considered. (auth)

22556 CHEMICAL FRACTIONATIONS IN METEORITES. V. VOLATILE AND SIDEROPHILE ELEMENTS IN ACHONDRITES AND OCEAN RIDGE BASALTS. Laul, J. C.; Keays, Reid R.; Ganapathy, R.; Anders, Edward; Morgan, John W. (Univ. of Chicago). Geochim. Cosmochim. Acta; 36: No. 3, 329-45(Mar 1972).

Eighteen achondrites and four terrestrial basalts (three ocean ridge, one continental) were analyzed by neutron activation analysis for Ag, Au, Bi, Br, Cd, Co, Cs, Cu, Ga, In, Ir, Rb, Se, Tl, and Zn. Samples included seven eucrites, five howardites, two nakhlites, two shergottites, an angrite, and an aubrite. Light and dark portions of the gas-rich meteorites Kapoeta and Pesyanoe were analyzed separately. Nakhlites and shergottites had volatile element abundances similar to those in ocean ridge basalts; eucrites, howardites, and angrites showed greater depletions by an order of magnitude and less similar abundance patterns. In terms of a two-component model of planetary accretion, the parent planets contained the following percentages of low-temperature material: eucrites 0.8, nakhlites 38, shergottites 28. Nominal accretion temperatures (°K) inferred from Tl contents were: eucrites 432°, nakhlites 438°, shergottites 433°, all for an assumed nebular pressure of 10^{-5} atm. These data appear to be consistent with the oxygen isotope composition of these meteorites. Shergottites may be genetically related to L-chondrites. The siderophile element pattern of achondrites resembles that of the Moon, but with less extreme depletions. Terrestrial basalts, on the other hand, show a different pattern, with a steep decline in the order Ag > Au > Ir. The dark portion of Kapoeta seems to contain 1 to 2% chondritic material, compositionally similar to Cl chondrites. No such enrichment was found for samples of Pesyanoe. (auth)

22557 CONTINUOUS ACTIVATION ANALYSIS OF FLOWING SOLUTIONS. I. THEORY OF CONTINUOUS ACTIVATION ANALYSIS. Kliment, V. (Inst. fuer Physik, Bratislava); Toelgyessy, J. Isotopenpraxis; 7: No. 11-12, 446-8(Nov-Dec 1971). (In German).

The principle and fundamental characteristics of continuous neutron activation analysis are described. A correlation was derived allowing determination of the optimum flow velocities of analyzed solutions. The accuracy of determination and the influence of interference reactions are discussed. (auth)

22558 DETERMINATION OF IMPURITIES BY ACTIVATION ANALYSIS. Miskei, M. (Research Inst. for Non-Ferrous Metals, Budapest). pp 365-74 of Proceedings of the Research Institute for Non-Ferrous Metals. Budapest; Akademiai Kiado (1971).

From Proceedings of the Research Institute for Non-Ferrous Metals; Budapest, Hungary (May 1968). See CONF-680568.

The use of destructive activation analysis for determining the amount of trace impurities in high-purity Al, Ga, and GaAs is discussed. The primary goal was the development of a separation method as universal as possible which could be used equally for Al, Ga, or GaAs without the need for basic changes of method and even for metals and products of the aluminum industry, which would appear at some later date (e.g., Al conductor wire, and Sb). Thus the trace impurities were separated from each other and from the macroelements by modern physicochemical methods, e.g., ion exchange chromatography, selective extraction with solvents, and distillation. Usually 6 to 7 trace impurities have been determined in GaAs and Ga and 10 to 25 elements in Al. The trace impurities belong chiefly to the second subgroups of the periodic system of elements. Comments on a lecture by the author on "Latest Results with the Focussing Ion Exchange Method" are included. (P.C.H.)

22559 FAST NEUTRON ACTIVATION ANALYSIS OF THE MAJOR BODY ELEMENTS. Biggin, H. C.; Morgan, W. D. (Birmingham Univ., Eng.). J. Nucl. Med.; 12: No. 12, 808-14 (Dec 1971).

Neutrons of energy up to 37 MeV were used in an attempt to estimate total-body oxygen, nitrogen, and carbon simultaneously by following the decay of the positron emitters ^{15}O, ^{13}N, and ^{11}C. These are formed by n, 2n reactions on ^{16}O, ^{14}N, and ^{12}C, respectively. After analysis of the complex decay of the annihilation radiation, the amount of each element was determined by comparison with a known standard and corrections for the interferences were applied. Mice and standard phantoms were irradiated and the whole-body induced gamma radiation measured. The accuracy of the determinations is such that the method can be employed in serial measurements where changes in elemental percentages are of interest rather than absolute levels. (M.C.G.)

22560 SOME APPLICATIONS OF NEUTRON ACTIVATION FOR THE ANALYSIS OF HUMAN BONE. Goode, G. C.; Howard, C. M.; Wilson, A. R.; Parsons, V. (Atomic Weapons Research Establishment, Aldermaston, Eng. Kings Coll., London). Anal. Chim. Acta; 58: No. 2, 363-8(feb 1972).

Nondestructive methods for the determination of fluorine, calcium, magnesium, sodium, chlorine, aluminum, vanadium, and manganese in human bone by neutron activation techniques are described. These are useful for analysis of small biopsy samples removed from patients in renal failure. Fluorine is first determined by the reaction $^{19}F(n,2n)^{18}F$, with 14-MeV neutrons from a Cockcroft–Walton accelerator. After decay of 110-min ^{18}F the remaining elements are determined by further irradiation with thermal neutrons followed by γ spectrometry with a least-squares fitting technique for spectral resolution. (auth)

22561 NEUTRON ACTIVATION AND ELECTRON MICROPROBE DETERMINATION OF Ti, Cr, Mn, AND Fe TRACES IN SAPPHIRE SINGLE CRYSTALS. Wyttenbach, Armin (Swiss Federal Inst. of Reactor Tech., Zurich); Blum, H. E.; Borer, W. J.; Eigenmann, K. H.; Guenthard, Hs. H. Anal. Chim. Acta; 58: No. 2, 355-62(Feb 1972).

Results of the nondestructive determination of titanium, chromium, manganese, and iron in concentrations below 700 ppM in synthetic sapphire by neutron activation and electron microprobe analysis are reported. It is shown that the results of the two methods are well correlated for Ti, Cr, and Mn. For iron, considerable discrepancies between the two methods were observed. The accuracy of the trace determination by both methods amounts to ca 6% rms deviation. (auth)

22562 FAST AND SIMPLE PERFORMANCE OF REPEATED LIQUID–LIQUID EXTRACTIONS IN RADIOCHEMICAL SEPARATION PROCESSES. Schmidt, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Isotopenpraxis; 7: No. 10, 416-18 (Oct 1971). (In German).

Simple equipment is described that permits repeated liquid/liquid-extractions rapidly, easily, and with small yield losses. The procedure proved to be particularly feasible for medium-speed radiochemical separations in activation analysis. It was applied in the determination of tin via 40-min-isotope ^{123}Sn. (auth)

22563 PRECISE MEASUREMENT OF MICROGRAM LEVELS ^{48}Ca IN BIOLOGIC SAMPLES BY NEUTRON-ACTIVATION ANALYSIS. Hansen, J. W. (Univ. of California, San Francisco); Prussin, S. G. Int. J. Appl. Radiat. Isotop.; 23: No. 3, 109-14 (Mar 1972).

An activation-analysis procedure is described, which affords measurements of ^{48}Ca in blood and urine specimens at microgram levels with errors of 2 to 3%. The various technical factors influencing error are discussed and the steps taken to minimize these errors are described. A number of these considerations are generally applicable to other activation methods for analysis of samples of biological origin. (auth)

22564 SEMICONDUCTOR GAMMA SPECTRA FOR NEUTRON ACTIVATION ANALYSIS. Vogg, Hubert. Buchreihe der Atomkernenergie, Band 6. Munich; Verlag Karl Thiemig (1971). 157p. DM 9,80. (In German and English).

No decay probability is indicated for the individual gamma lines. The main line was assumed to be 100% and all other lines were referred to this level. The confidence level expected from this method is ±10% relatively. Radionuclides are included that are generated by activation with reactor neutrons and can be regarded as characteristic activation products for analytical purposes. At the end of the collection of spectra, all gamma lines are listed in the order of rising energy numbers. (M.C.G.)

22565 APPLICATION OF TRIPLE COINCIDENCE COUNTING AND OF FIRE-ASSAY SEPARATION TO THE NEUTRON-ACTIVATION DETERMINATION OF IRIDIUM. Greenland,

L. Paul; Rowe, J. J.; Dinnin, J. I. U. S., Geol. Surv., Prof. Pap.; No. 750-B, 175-9(1971).

Two procedures for determination of iridium in meteorites, ores, and rocks by neutron activation are described. Both require irradiation of 1-g samples for 12 to 16 hours in a neutron flux of 7×10^{12}n cm^{-2} sec^{-1}. In the first procedure, applicable to the range of iridium concentration of 1 to 1,000 parts per billion, samples are counted directly (without chemical separations) with three NaI(Tl) detectors, which are gated through single-channel analyzers on the 0.308-, 0.296-, and 0.316-MeV ^{192}Ir gamma cascade; the associated multichannel analyzer records only those events that simultaneously pass all single-channel analyzers. This counting system is specific to ^{192}Ir, but the poor counting efficiency limits its usefulness to samples containing more than 1 ppB of Ir. The second procedure uses a fire-assay separation for iridium concentrations in the 0.001 to 10 ppB range. Samples are fused in the presence of iridium carrier by standard techniques to obtain a Pt–Rh–Ir bead. The final bead is counted in double coincidence to eliminate interference from ^{110m}Ag and fission-produced ruthenium, which are also present in the bead. Both procedures require long counting times (as much as 24 hours) but are very fast in terms of man-work hours. The simplicity of the procedures makes them well suited to routine analysis. (auth)

22566 SUBSTOICHIOMETRIC DETERMINATION OF TANTALUM BY NEUTRON ACTIVATION. Greenland, L. Paul; Campbell, E. Y. U. S., Geol. Surv., Prof. Pap.; No. 750-B, 191-3(1971).

A rapid radiochemical separation of tantalum utilizing substoichiometric extraction of the tantalum tetra-N-pentylammonium bromide (TPABr) complex for the chemical yield determination is described. After hydrofluoric–sulfuric acid or sodium peroxide decomposition of silicate rocks, tantalum is radiochemically purified by methyl isobutyl ketone (MIBK) extraction from hydrofluoric–sulfuric acid media, back extraction to ammonium hydroxide, and chloroform extraction of the TPABr complex from hydrofluoric acid. Results from the U. S. Geological Survey rocks are presented. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 22695, 22889, 22924, 23357, and 24780.

22567 (IA-1244) SPECTROCHEMICAL DETERMINATION OF LITHIUM, RUBIDIUM, AND CESIUM IN GEOLOGICAL STANDARDS. Bircz, R. (Israel Atomic Energy Commission, Tel Aviv). Sep 1971. 15p. Dep. NTIS (U. S. Sales Only).

Spectrochemical determinations of Li, Rb, and Cs were carried out in all of the available geological standards. In general the results are in agreement with the data reported in the literature. (auth)

22568 MICROTITRIMETRIC DETERMINATION OF URANIUM IN NITRIC ACID MEDIUM IN THE PRESENCE OF EXCESS OF IRON, MAGNESIUM, AND ALUMINUM. Mareska, V. (Nuclear Research Inst., Prague). Talanta; 19: No. 2, 214-17(Feb 1972).

The Davies and Gray procedure (Talanta 11: 1203(1964)) for determination of uranium in the presence of nitric acid was scaled down to permit the analysis of solutions 0 to 9M in nitric acid and containing 20 to 3000 μg of uranium. The original method required modification in the scaled-down version, the main alterations being removal of NO by rapid stirring during the oxidation of excess of iron(II), and an increase in the amount of two of the reagents. Several analyses can be done together. (auth)

22569 SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF THORIUM IN LANTHANUM OXIDE. Rajkovic, D. (Inst. for Tech. of Nuclear Raw Materials, Belgrade). Analyst; 97: No. 1151, 114-17(Feb 1972).

A spectrophotometric method for the determination of trace amounts of thorium in lanthanum oxide or lanthanum metal was developed. The method is based on the determination of thorium with thoron after its separation from lanthanum by extraction with a mixture of ethyl acetate and acetone. The efficiency of the separation was tested with ^{140}La tracer. Other elements present in lanthanum oxide as impurities do not interfere. Thorium contents down to 10 ppM can be determined in a 1-g sample with 1-cm cells used for absorbance measurement. Errors of determination are within the range ±5%. The relative standard deviations on samples containing 30 and 100 ppM of thorium were 1.6 and 1%, respectively. (auth)

22570 ANALYTICAL STANDARDS FOR ACCOUNTABILITY OF URANIUM TETRAFLUORIDE. New York; American National Standards Institute [(1970)]. 63p.

An analytical standard for the accountability of uranium tetrafluoride is presented that includes procedures for subsampling, determination of uranium, determination of metallic impurities, conversion of uranium tetrafluoride to uranium hexafluoride for gas mass spectrometry, and isotopic analysis by gas and thermal ionization mass spectrometry. (auth)

22571 EMISSION-SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF BORON IN NUCLEAR-GRADE GRAPHITE. Rossi, G.; Soldani, G. (EURATOM–CCR, Ispra, Italy). Analyst; 97: No. 1151, 124-30(Feb 1972).

A rapid, highly sensitive method is described for the spectrographic determination of boron in nuclear-grade graphite. Boron, present in the sample in the form of boron carbide (B_4C), is volatilized as the trifluoride by the addition of 1 percent of Kel-F powder (polychlorotrifluoroethylene) to the samples. The samples, containing 500 ppM silicon as the internal standard, are excited by a 10-A dc arc in the presence of an argon controlled atmosphere. A linear relationship between the intensity ratio of the lines boron 249.773 nm and silicon 245.214 nm and the boron concentration was established in the boron concentration range 0.1 to 5 ppM. The relative standard deviation, calculated from twelve determinations on each sample, ranged from ±8 percent (at 5 ppM boron) to ±11 percent (at 0.1 ppM boron). (auth)

22572 DETERMINATION OF SMALL QUANTITIES OF CERIUM IN STEEL AND PIG IRON. Filipov, D. Ch.; Natchev, I. R. Compt. Rend. Acad. Bulg. Sci.; 24: No. 5, 637-40(1971). (In French).

In the photometric determination of Ce in the presence of EDTA, H_2O_2, and ammonia, Be precipitates as the hydroxide and interferes with the determination. A method was developed, which avoids the Be interference: to a H_2O_2, NH_4F, and EDTA medium, sufficient NH_4OH is added to yield a pH of 8.5 to 9.0. The F^- ion prevents Be from precipitating and permits a photometric determination of Ce in steel and pig iron. Other elements are either removed by a prior ether extraction from a HCl solution, or are precipitated by NH_4OH in the presence of EDTA, using Be as a collector. (K.S.W.)

22573 COMPOSITION OF HYDROMETALLURGICAL MOLYBDENUM CONCENTRATES (HMC). Gromozova, I. K.; Lebedeva, L. I. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 7, 1511-13 (Jul 1971).

Translated from Zh. Prikl. Khim.; 44: No. 7, 1488-91(Jul 1971).

HMC has the composition (%) Mo 54 to 58, WO_3 2 to 2.5, SiO_2 0.1 to 0.4, Na_2O 0.5 to 0.8, Cu 0.005 to 0.01, P 0.005 to 0.01, As 0.03 to 0.05, S 10 to 15, and Sn trace. An attempt was made to investigate the forms in which Mo and S are present. Methods of determining Mo and S were compared and a method adopted that involved boiling in NaOH, acid dissolution of the residue, and vanadatometric determination of Mo. It was present in two oxidation states (VI and IV). The sulfur was present as sulfide and sulfate. (M.C.G.)

22574 NEW POTENTIOMETRIC METHOD FOR THE DETERMINATION OF LANTHANUM. Hussain, R. C.; Raju, N. Appala (Sri Venkateswara Univ., Tirupati, India). Curr. Sci. (India); 41: No. 6, 230-1(20 Mar 1972).

Sodium fluoride is used as the titrant and the end point is indicated by potentiometry. The Fe(III)/Fe(II) system can be used as an indicator solution. (M.C.G.)

22575 DETERMINATION OF MOLYDBENUM TRIOXIDE, TOTAL MOLYBDENUM, AND TOTAL SULFUR CONTENT OF MOLYBDENUM DISULFIDE. Angelotti, N. C.; Gooch, E. G. (Dow Corning Corp., Midland, Mich.). Anal. Chim. Acta; 58: No. 2, 445-7(Feb 1972).

It is shown that the analysis time can be reduced by a factor of 3 to 4 if the conventional procedure to solubilize the sample is followed by an atomic absorption measurement. MoO_3 is leached from the MoS_2. A separate sample is roasted and then dissolved in the ammonia solution. Then atomic absorption measurements are carried out. The sulfur content is determined using a Leco sulfur analyzer. (M.C.G.)

22576 EFFECT OF GAMMA RADIATION ON COLORIMETRIC DETERMINATION OF IRON. Zittel, H. E. (Oak Ridge National Lab., Tenn.). Anal. Chim. Acta; 58: No. 2, 323-9(Feb 1972).

The effect of γ radiation on the spectrophotometric determination of iron by three major methods was studied. The thiocyanate method is particularly sensitive to γ radiation because the iron(II) formed by reaction of thiocyanic acid and iron(III) is radiolytically reoxidized. It was proven that the positive error caused by γ radiation on the 1,10-phenanthroline method is due to radiolysis

of the constituents of the blank and not the iron complex. This error may be largely eliminated by carrying a blank through the total procedure under radiation and reading the sample against the blank. The radioinduced error in the α,α'-bipyridyl method was not found to be of the same nature and is therefore not amenable to the same correction. Data on the radiolysis effect on each of these methods are presented. (auth)

22577 ANALYTICAL USES OF CHARGE-TRANSFER COMPLEXATION: SPECTROPHOTOMETRIC METHOD FOR IODIDE IN WATER. Poziomek, Edward J.; Reger, David W. (Physical Research Lab., Edgewood Arsenal, Md.). Anal. Chim. Acta; 58: No. 2, 459-62(Feb 1972).

Spectrophotometric analysis of water samples containing chloride, bromide, and/or perchlorate anions for iodides is described. The uv absorption of the 4-cyano-1-methylpyridinium iodide charge-transfer complex in the region 340 to 350 nm serves as a measure of the iodide. The iodide can be determined in the 0.01 to 1.0% range in the presence of appreciable concentrations of chloride, bromide, and/or perchlorate anions. (M.C.G.)

22578 INTERFERENCE OF TITANIUM IN THE DETERMINATION OF THORIUM IN ROCKS WITH ARSENAZO III. Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Anal. Chim. Acta; 58: No. 2, 463-7(Feb 1972).

The effects of various concentrations of titanium and Arsenazo III on the spectrophotometric determination were determined. Results were obtained by direct addition of titanium and omitting the Alanine-336 extraction. (M.C.G.)

22579 DETERMINATION OF TELLURIUM IN GEOLOGIC MATERIALS IN THE PARTS-PER-BILLION RANGE. Hubert, A. E. U. S., Geol. Surv., Prof. Pap.; No. 750-B, 188-90(1971).

A sensitive method useful in geochemical exploration was developed for the determination of tellurium in geologic material. In this method the sample is digested with hydrobromic acid and bromine, and the tellurium is extracted into methyl isobutyl ketone and stripped from the organic phase with water. Tellurium is then measured indirectly by its catalytic action on the reduction of gold by hypophosphorous acid. Results by this method compare favorably with those obtained by atomic absorption. The lower limit of sensitivity by the catalytic method is 5 ppB, whereas existing atomic absorption methods provide a sensitivity of 100 ppB. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstract 22903.

22580 (ANCR-1055) RELATIVELY SIMPLE AND PRECISE TECHNIQUE FOR THE ASSAY OF PLUTONIUM WASTE. Cline, J. E. (Aerojet Nuclear Co., Idaho Falls, Idaho). Feb 1972. Contract AT(10-1)-1375. 31p. Dep. NTIS.

A technique is described for use in the assay of plutonium waste. The method is that of passive Ge(Li) γ spectroscopy using a technique of differential absorption of the plutonium gamma rays themselves to determine the absorption correction. The analytic technique is simple and relatively quick requiring a simple measurement of about 20 minutes to obtain total plutonium content and relative isotopic abundances. Described in the document is the analytic technique, the instrumentation required, the experimental technique and analysis, and a typical analysis. Attempts are made to describe the limitations and uncertainties in the measurement technique. (auth)

Separation Procedures

Refer also to abstracts 22604 and 22605.

22581 (INR-P-1339) PHYSICAL CHEMISTRY OF EXTRACTION PROCESSES. Siekierski, Slawomir (Institute of Nuclear Research, Warsaw (Poland)). 1971. 10p. (CONF-700540-1). Dep. NTIS (U. S. Sales Only).

From Polish-Italian seminar on some chemical, ceramic, and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

The thermodynamics of the extraction process, based on the modern theory of the structure of liquid water is discussed. A significant increase in the entropy of the system due to the removal of an uncharged organic molecule from the aqueous phase and connected with the change of the structure of water is a main factor determining the transfer of the molecule from the aqueous to the organic phase. The model described can be applied to the description of the extraction mechanism of metals in the forms of chelates, solvated salts, and ion-pairs. (auth)

22582 SEPARATION OF CURIUM FROM NEUTRON IRRADIATED ^{241}Am. Ueno, Kaoru; Watanabe, Kenju; Sagawa, Chiaki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 113-15(Feb 1972).

The conditions under which curium can be separated from an irradiated ^{241}Am target are discussed. The isolation process consists of three steps. In the first step, Am(III) is oxidized to the pentavalent state in a dilute nitric acid solution, and then plutonium and curium are extracted from the irradiated target by solvent extraction with bis(2-ethylhexyl) phosphate (HDEHP). Curium in the organic phase is back-extracted with 1N nitric acid, and thereafter plutonium with a reducing solution containing ferrous sulfamate. The curium is finally purified by cation exchange, using α-hydroxyisobutyrate as the eluting solution. About 0.4 μg of ^{242}Cm and 4×10^{-3} μg of ^{243}Cm were found in the curium fraction, which had been separated from 1 mg of irradiated ^{241}Am sample. (auth)

22583 CONTROL AND AUTOMATION OF SOLVENT EXTRACTION PROCESSES. Mills, A. L. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Rep. Progr. Appl. Chem.; 55: 371-4(1971).

A brief review is given of recent work on the subject, mainly in connection with separation of the lanthanides or the actinides. 22 references. (UK)

22584 EXTRACTION OF Ta FROM HCl–H_2SO_4 SOLUTIONS BY ALCOHOLS. Petunina, N. I.; Chufarova, I. G. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 127-30(1970). (In Russian).

The process of extraction of Ta by various aliphatic alcohols from HCl–H_2SO_4 solutions was studied as a function of the molecular weight of the alcohol, HCl concentration, and the length of time of standing of the original solutions. All alcohols tested, from C_6 to C_{18}, were effective extractants for Ta. The effects of F^- concentration where Ta : F = 1.25 to 1.50 promoted the transition of the polymeric nonextractable form of Ta to the extractable monomeric anion complex. (tr-auth)

22585 EXTRACTION OF NIOBIUM FROM HCl–H_2SO_4 SOLUTIONS BY ALCOHOLS. Chufarova, I. G.; Petunina, N. I. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 117-22(1970). (In Russian).

The extraction of Nb from HCl–H_2SO_4 solutions by alcohols, which contained from 6 to 18 C atoms, was studied. With an increase in molecular weight of the alcohol the distribution coefficient of Nb was raised. The extent of Nb extraction was also enhanced by the substitution of a secondary alcohol for a primary. The higher secondary alcohols proved to be the best extractants for Nb from the acid mixture, and the mutual influence of Nb and Ti in such systems was considered. (tr-auth)

22586 STUDY OF RARE EARTH EDTA COMPLEXES BY INFRARED SPECTROPHOTOMETRY. Mink, J.; Chowdhary, S. Y.; Vegh, G. (Isotope Inst., Budapest). Radiochem. Radioanal. Lett.; 9: No. 4, 295-302(4 Mar 1972).

Infrared spectra of samarium and ytterbium EDTA complexes were studied. A method has been worked out to separate the different complexes by electrophoresis. The probable compositions of these complexes are discussed. (auth)

22587 ADSORPTION PROPERTIES OF PHOSPHOANTIMONIC ACID SUPPORTED ON SILICA GEL. Caletka, R.; Konecny, C. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 9: No. 4, 285-93(4 Mar 1972).

The preparation of phosphoantimonic acid supported on silica gel under various experimental conditions was investigated in order to ascertain the suitability of individual species as ion exchange materials for the recovery of alkali metal and strontium ions from nitric acid solutions. (auth)

22588 YTTRIUM PURIFICATION PROCESS. Trimble, Carter H.; Strott, David B. (to Molybdenum Corp. of America). U. S. Patent 3,640,678. 8 Feb 1972. Filed 1 Jun 1970.

Pure yttrium values are isolated continuously from aqueous solutions of yttrium and rare earth values in a two or three circuit liquid–liquid extraction system using an amine extractant in one circuit to remove lower atomic number rare earth values and a (halodi- or trialkyl)alkanoic acid extractant in the other circuit or circuits to remove higher atomic number rare earth values. Efficiency is enhanced by using a salting out agent in the amine extractant circuit and separating the yttrium values from the salting out agent by extraction in an intermediate carboxylic acid extractant circuit. (auth)

22589 SOLVENT EXTRACTION IN THE ATOMIC ENERGY INDUSTRY. Jenkins, I. L. (Atomic Energy Research Establishment, Harwell, Eng.). Rep. Progr. Appl. Chem.; 55: 375-83 (1971).

A review of recent progress in this field is presented under the following headings: general introduction; U recovery; Th recovery; use of trilaurylamine; processing of U–Th fuels; fuels containing Be; fuels containing Mo; Pu processing; Pu purification; recovery of Np; general considerations; production of the rarer actinides and recovery of fission products and other elements. (64 references.) (UK)

22590 BEHAVIOR OF TITANIUM AND IRON IMPURITIES DURING PRODUCTION OF VARIOUS ZIRCONIUM COMPOUNDS. Kolenkova, M. A.; Sazhina, V. A.; Samaryanova, L. B.; Motina, A. G. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 7, 1475-8 (Jul 1971).

Translated from Zh. Prikl. Khim.; 44: No. 7, 1449-54(Jul 1971).

Optimal conditions were determined for separation of zirconium compounds from solutions containing iron and titanium impurities. Coprecipitation of the impurities with precipitation of zirconium sulfate was studied and removal of the impurities considered. (M.C.G.)

22591 COMPARISON OF SOME READY-FOR-USE THIN LAYERS FOR THE SEPARATION OF HEAVY METALS WITH BUTANOL–3 N HCl. Prosperi, T.; Lederer, M. (CNR, Rome). J. Chromatogr.; 65: No. 2, 460-2(23 Feb 1972).

Various materials were investigated in regard to use for ready-to-use thin layers for the chromatography of heavy metal ions. Butanol–3N HCl was used as the solvent. Good chromatograms were obtained on various celluloses and polyamide II layers. Poor results were obtained with aluminum foil, silica gel, alumina, polyamide 6, and acetylated cellulose layers. Results are tabulated for Pb, Hg, Bi, Cu, Cd, As, Sb, Sn, Fe, Zn, Mn, Co, Ni, Au, Pt, Pd, Tl, and UO_2^{++} ions. (J.G.B.)

22592 IMPROVED METHOD FOR THE RECOVERY OF COMPOUNDS FROM PAPER CHROMATOGRAMS. Eshdat, Y.; Mirelman, D. (Weizmann Inst. of Science, Rehovot, Israel). J. Chromatogr.; 65: No. 2, 458-9(23 Feb 1972).

A quick, simple, and efficient method for eluting compounds from paper chromatograms was developed. Small volumes of eluant and standard laboratory equipment, including a polypropylene centrifuge tube and the barrel of a disposable syringe, are used. Repeated elutions are performed on the paper chromatogram that has been cut in strips and placed in the centrifuge. Three to four elutions are sufficient to remove 99% of the total radioactivity present. The procedure has been successfully used to elute a variety of compounds from chromatograms and electropherograms. (J.G.B.)

22593 EXTRACTION OF URANYL 2-THENOYLTRIFLUOROACETONE COMPLEXES INTO ALCOHOL, KETONE, ETHER, AND ESTER SOLVENTS. Akiba, Kenichi; Suzuki, Nobuo; Kanno, Takuji (Tohoku Univ., Sendai). Anal. Chim. Acta; 58: No. 2, 379-87(Feb 1972).

The extraction of the 2-thenoyltrifluoroacetone (TTA) complex of uranyl ion into four types of solvents containing donor solvents was investigated. The species extracted was found to be $UO_2A_2 \cdot S$ (S = alcohol, ketone, ether, and ester). The extraction was much enhanced with donor solvents. The distribution ratios (D_M) were estimated by means of the equations, $\log D_M = a \log P_{H_2} + b$, and $\log D_M = \log D_{Zn} + c$ (where a, b, and c is constant). The estimated values were in good agreement with the observed values in a number of oxygen-containing solvents. The regularities in extraction are discussed in terms of the two main roles of donor solvents, as medium and as coordinating reagent. (auth)

22594 THERMOGRAVIMETRIC AND GAS-CHROMATOGRAPHIC STUDY OF NEODYMIUM, GADOLINIUM, AND ERBIUM β-DIKETONE CHELATES. Utsunomiya, Kei; Shigematsu, Tsunenobu (Kyoto Univ.). Anal. Chim. Acta; 58: No. 2, 411-19(Feb 1972).

Various β-diketone chelates of neodymium, gadolinium and erbium were prepared. Hydrate formation and hydroxyl content of the chelates were studied by ir spectra in the region 3000 to 3700 cm^{-1}. The TGA curves of the chelates showed that dipivaloylmethane (DPM), isobutyrylpivaloylmethane (IBPM), and trifluoroacetylpivaloylmethane (TPM) chelates sublimed quantitatively at 150 to 270°C; diisobutyrylmethane (Gd, Er), pivaloylpropionylmethane (Er), trifluoroacetylisobutyrylmethane (Gd, Er), trifluoroacetyl-α-methylbutyrylmethane (Er), and trifluoroacetylisovalerylmethane (Er) chelates partially volatilized, and the other chelates decomposed without sublimation. Generally, the anhydrous tris-chelates sublimed quantitatively, and the basic rare earth β-diketonates and hydrated chelates decomposed. Among the β-diketones studied HIBPM, HDPM, and HTPM seem to be useful reagents for the gas chromatography of the rare earth elements. (auth)

22595 STUDY OF THE SOLVENT EXTRACTION OF RUTHENIUM BY ORGANIC REAGENTS FROM DILUTED AQUEOUS SOLUTIONS. Bruchertseifer, H.; Koch, H. (Central Inst. for Isotope and Radiation Research, Leipzig). Isotopenpraxis; 7: No. 10, 406-11(Oct 1971).

Using nuclide ^{106}Ru the extraction of ruthenium by some usual organic reagents and various solvent was studied with the aim to obtain information on the complex chemical behavior of ruthenium(IV) in dilute solutions and on the mechanism of the extraction. A characteristic of ruthenium(IV) species in solution is its reaction inertia, which manifested itself in the influence of reaction time and temperature on the distribution ratio. It was established that with the most varied of reagents ruthenium(IV) forms stable complexes even in acid aqueous solutions, which may prevent a precipitation of the hydroxide or losses through the adsorption of the radiocolloids and permit an extractive separation of micro ruthenium quantities from aqueous solutions with yields of more than 90%. (auth)

22596 THERMODYNAMICS OF EXTRACTION OF ZIRCONIUM FROM $HClO_4$ AND HNO_3 SOLUTIONS IN THE PRESENCE OF OXALIC ACID. Solovkin, A. S.; Ivantsov, A. I. Zh. Neorg. Khim.; 16: No. 8, 3347-50(Aug 1971). (In Russian).

The extraction of Zr in a monomeric state by solutions of 2-thenoyltrifluoroacetone (TTA), or TBP from an aqueous phase containing oxalic acid was investigated. A thermodynamic analysis of the data indicated that the following reaction was taking place: $Zr(OH)_3^+ + H_2C_2O_4 \rightleftharpoons Zr(OH)_2C_2O_4 + 2\,H^+$, which had a $K_{eq} = 4 \times 10^6$. The mechanism of the Zr extraction by solutions of TTA in benzene required that the TTA extract the Zr from $HClO_4$ or HNO_3 solutions forming the compounds, ZrA_4, $Zr(ClO_4)A_3$, and $Zr(NO_3)A_3$. For the formation of the latter compounds the equilibrium constant is 6×10^{10}, 4×10^8, and 9.8×10^7, respectively. (tr-auth)

22597 ION EXCHANGE SEPARATION OF MIXTURES OF RARE EARTH ELEMENTS DURING ELUTION BY SOLUTIONS OF SALTS OF DIETHYLENETRIAMINEPENTAACETIC ACID. Martynenko, L. I.; Varlamova, G. L.; Pechurova, N. I.; Spitsyn, V. I. Zh. Neorg. Khim.; 16: No. 8, 2244-6(Aug 1971). (In Russian).

An ion exchange separation of a Pr–Nd mixture was carried out in the manner of Spedding, using diethylenetriaminepentaacetic acid as an eluate. The mechanism of ion exchange was studied under conditions similar to those of a separation procedure. The primary complex formation plays a highly important role in the process. (tr-auth)

22598 EXTRACTION OF THIOCYANATE COMPLEXES OF ZIRCONIUM AND HAFNIUM BY NEUTRAL ORGANOPHOSPHORUS COMPOUNDS. Sinegribova, O. A.; Yagodin, G. A. Zh. Neorg. Khim.; 16: No. 8, 2237-43(Aug 1971). (In Russian).

Under conditions of moderate acidity Zr and Hf were extracted by extractants such as TBP, diisoamyl methyl phosphinate, and trioctyl phosphine oxide, in the form of hydrolyzed thiocyanate complexes solvated with two molecules of the extractant. Extraction of mixed solvates containing thiocyanate and the thiocyanate metal complex did not occur. The preferential extraction of Hf is explained by its greater tendency toward complex formation with the thiocyanate ion and the formation of a solvate–thiocyanate complex with the extractant. (K.S.W.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 22581.

22599 RESEARCH IN SURFACE FORCES. VOLUME 3. Deryagin, B. V. (ed.). New York; Plenum Publishing Corporation (1971). 456p. $47.50.

Translated from Issledovaniya v Oblasti Poverkhnostnykh Sil by J. E. S. Bradley.

Fifty-four papers are presented as the proceedings of the Third Conference on Surface Forces. They are arranged into eight sections dealing with anomalous properties of liquid boundary layers; surface forces in thin films; thermodynamics and stability of thin films; stability in dispersed systems; kinetic effects in thin liquid films; transport effects in disperse systems and porous bodies; surface forces in adhesion, cohesion, and friction; and surface forces in gases. (D.L.C.)

Chemical and Physical-Chemical Properties

Refer also to abstracts 22590, 22665, 22670, 22680, 22685, and 24985.

22600 (ORNL-4728, pp 45-110) CHEMISTRY. (Oak Ridge National Lab., Tenn.). Feb 1972.

In Molten-Salt Reactor Program.

BARIUM—distribution between molten bismuth–lead eutectic and breeder fuel solvent
BERYLLIUM FLUORIDES—BeF_2–LiF–ThF_4, protactinium precipitation by oxide in molten, effects of uranium additions on
—BeF_2–NaF, electric conductivity of molten and supercooled
—BeF_2–NaF, phase diagram and glass transition temperature of
—BeF_2–LiF, solvent properties of molten, for hydrogen
BORON FLUORIDES—solubility in molten fluorides
CERIUM—separation from molten lithium chloride by sorption on Zeolite
CESIUM ISOTOPES—content and distribution in MSRE moderator graphite
FISSION PRODUCTS—deposition in circulating system of MSRE
FLUORIDES—analysis of flowing molten, in-line
—spectra of molten, absorption
GRAPHITE—analysis and examination of MSRE moderator
HYDROGEN—solubility in molten fluorides
—determination in fluoroborates
LITHIUM CHLORIDES—separation of cerium from molten, by sorption on Zeolite
LITHIUM FLUORIDES—BeF_2–LiF, solvent properties of molten, for hydrogen
—BeF_2–LiF–ThF_4, protactinium precipitation by oxide in molten, effects of uranium additions on
LITHIUM FLUOROBORATES—enthalpy at 298 to 700°K
—entropy of
MOLTEN SALT BREEDER REACTOR—chemistry studies for, progress in
—tritium production and control in
MOLTEN SALT REACTOR EXPERIMENT—chemistry studies for, progress in
—fission product deposition in circulating system of
—metal transfer in
PROTACTINIUM—precipitation by oxide in molten fluorides
RADIOISOTOPES—content and distribution in MSRE moderator graphite
REACTOR FUELS—analysis of molten salt
SODIUM FLUORIDES—BeF_2–NaF, phase diagram and glass transition temperature of
—BeF_2–NaF, electric conductivity of molten and supercooled
SODIUM FLUOROBORATES—analyses for hydrolysis products, in-line
THORIUM—distribution between molten bismuth–lead eutectic and breeder fuel solvent
THORIUM FLUORIDES ThF_4—BeF_2–LiF–ThF_4, protactinium precipitation by oxide in molten, effects of uranium additions on
TRITIUM—production and control in MSBR
URANIUM—determination in flowing molten fluoride streams, in-line (M.C.G.)

22601 INORGANIC REACTION MECHANISMS. Edwards, John O. (ed.). Progress in Inorganic Chemistry, Volume 13. New York; John Wiley and Sons, Inc. (1970). 357p. $15.95.

Included are reviews by active inorganic chemists working in the field of mechanisms. The six sections deal with the formation, structure, and reactions of binuclear complexes of cobalt; fast metal complex reactions; recent developments in the redox chemistry of peroxides; replacement as a prerequisite to redox processes; nonbridging ligands in electron-transfer reactions; and the intimate mechanism of replacement in d^8 square-planar complexes. Subject and cumulative indexes are included. (J.G.B.)

22602 PROGRESS IN INORGANIC CHEMISTRY. VOLUME 14. Lippard, Stephen J. (ed.). New York; John Wiley and Sons, Inc. (1971). 446p. $24.95.

Chapter titles include: studies of dynamic organometallic compounds of the transition metals by means of nuclear magnetic resonance; inorganic electrosynthesis in nonaqueous solvents; single crystal and gas phase Raman spectroscopy in inorganic chemistry; and the stereochemistry of bis-chelate metal (II) complexes. The discussion on electronic spectroscopy of high-temperature open-shell polyatomic molecules is abstracted separately for NSA. Author, subject, and cumulative indexes are included. (J.G.B.)

For abstract of an individual chapter see: 22603.

22603 ELECTRONIC SPECTROSCOPY OF HIGH TEMPERATURE OPEN SHELL POLYATOMIC MOLECULES. Gruen, D. M. (Argonne National Lab., Ill.). Progr. Inorg. Chem.; 14: 119-72 (1971).

Section titles include: introduction to high temperature open shell diatomic molecules; ligand field calculations of 3d dihalides; absorption and fluorescence spectra of 3d dihalide molecules; hypersensitive transitions in gaseous lanthanide trihalides; and, absorption spectra of gaseous and matrix isolated actinide halides, including discussions on spectra of matrix isolated UCl_4 and UBr_4 molecules and gaseous UCl_5. (148 references) (J.G.B.)

22604 SODIUM CHALCOGENOTELLURITES. Zaltseva, I. G.; Greiver, T. N.; Sal'dau, E. P. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 7, 1502-6(Jul 1971).

Translated from Zh. Prikl. Khim.; 44: No. 7, 1479-84(Jul 1971).

In development of a method for separation of selenium from tellurium, the behavior of tellurium in solutions of sodium selenides and sulfides and conditions of formation of various chalcogenotellurites were studied. Sodium telluroselenides and sodium selenotellurites were formed. (M.C.G.)

22605 INTERACTION OF CHLORIDES OF RARE-EARTH (RE) ELEMENTS WITH ALKALI CARBONATES IN SOLUTION. Tselik, I. N.; Deineka, G. F.; Fedorenko, V. D. J. Appl. Chem. USSR(Engl. Transl.); 44: No. 7, 1467-70(Jul 1971).

Translated from Zh. Prikl. Khim.; 44: No. 7, 1441-5(Jul 1971).

Study of interaction of chlorides of lanthanum, neodymium, gadolinium, dysprosium, yttrium, and erbium at two initial Ln^{3+} concentrations (50×10^{-4} and 20×10^{-2} g-ion/liter) with the carbonates of potassium, sodium, and ammonium in solution at 25°C demonstrated the influence of alkali metal concentrations on the solubility of rare earth carbonates and composition of solid phases in $LnCl_3$–M_2CO_3–H_2O systems. It was shown by the solubility method and by chemical and thermogravimetric analyses of the solid phases that normal carbonates separate out in all the systems at an initial Ln^{3+} concentration of 50×10^{-4} g-ion/liter and molar ratios CO_3^{2-} : $Ln^{3+} \leq 2$. At higher CO_3^{2-} : Ln^{3+} ratios the corresponding double carbonates of variable composition are precipitated in all the systems at two initial Ln^{3+} concentrations (50×10^{-4} and 20×10^{-2} g-ion/liter); the solubility of these precipitates in excess precipitant increases in the series NH_4–Na–K. Because of the considerable solubility differences in the $LnCl_3$–Na_2CO_3–H_2O and $LnCl_3$–K_2CO_3–H_2O systems, it is possible to concentrate individual rare earth elements by fractional isolation of carbonate complexes from solutions. (auth)

22606 SPECTROSCOPIC PROPERTIES OF INORGANIC AND ORGANOMETALLIC COMPOUNDS. VOLUMES 1–4. Greenwood, N. N. A Specialist Periodical Report. London; The Chemical Society (1968-1971).

Annual literature reviews are presented covering the years 1967 to 1970, under the following main headings: Nuclear magnetic resonance spectroscopy; nuclear quadrupole resonance spectra; electron spin resonance spectroscopy; microwave spectroscopy; vibrational spectra; electronic spectra, and Moessbauer spectroscopy. (UK)

22607 STABILITY CONSTANTS OF MIXED-LIGAND COMPLEXES OF URANYL ION WITH CARBOXYLIC ACIDS. Balakrishnan, M. S.; Santappa, M. (Univ. of Madras). Curr. Sci. (India); 41: No. 5, 174-6(5 Mar 1972).

Mixed complexes of UO_2^{2+} and systems of monobasic acid + monobasic acid, monobasic acid + dibasic acid, dibasic acid + dibasic acid were investigated. Stability constants and error limits are presented. (J.G.B.)

Isotope Effects

Refer also to abstract 22642.

22608 KINETIC DEUTERIUM ISOTOPE EFFECTS IN THE REACTIONS OF METHYL IODIDE WITH AZIDE AND ACETATE IONS IN AQUEOUS SOLUTION. Won, Chong Min; Willi, Alfred V. (Columbia Univ., New York). Contract AT(30-1)-3796. J. Phys. Chem.; 76: No. 3, 427-32(3 Feb 1972).

The kinetic α-deuterium isotope effect was determined for the reactions of CH_3I (CD_3I) in aqueous solutions with azide ion from 10 to 40° and with acetate ion at 40°. Kinetic measurements were

carried out in reaction with no gas phase. Rate constants of the reaction of methyl iodide with acetate ion are corrected for simultaneous solvolysis. Results indicate inverse isotope effects: $k_H/k_D = 0.907$ ($CH_3I + N_3^-$), and 0.882 ($CH_3I + CH_3COO^-$) at 40°. The experimental data for the reaction with N_3^- are compared with results of model calculations of isotope effects from force constant with an electronic computer. Reasonable choices are made for the transition state force constants f_{Cl}, f_{CN}, f_{I2}, f_{HCl}, and the force constants not involving reacting bonds. The bending force constant f_{HCN} (in general: f_{HCY}) is adjusted to fit the experimental isotope effect at one temperature. Good agreement then is obtained between calculated and experimental isotope effects at all four temperatures. In the series $CH_3I + S_2O_3^{2-}$, CN^-, N_3^-, or CH_3COO^-, a very good correlation exists between the values of k_H/k_D and $\Delta G^{\ddagger}$, but there is no relationship between $\Delta G^{\ddagger}$ (or the nucleophilic power of Y^-, respectively) and the adjusted value of the bending force constant, f_{HCY}. The particular role of solvation in the SN2 transition state is discussed. The models of the isotope effect calculations must be improved to take care of the solvation of the groups X and Y. (auth)

22609 SELF-DIFFUSION AND THE ISOTOPE EFFECT IN GRAIN BOUNDARIES IN SILVER. Robinson, John Thomas. Austin, Tex.; Univ. of Texas (1970). 96p. University Microfilms Order No. 72-2410.

Thesis.

The self-diffusion in grain boundaries in silver was measured using the sectioning technique for polycrystal, ⟨100⟩ tilt bicrystals, and ⟨112⟩ tilt bicrystals over the temperature ranges 350 to 555°C, 400 to 500°C, and 350 to 498°C, respectively. The penetration plots indicate that the Suzuoka instantaneous source boundary condition is relaxed by surface diffusion. Also, there is evidence that dislocation networks not in the grain boundary lead to tails in the penetration plots. The temperature dependence of D_B' from the Suzuoka solution is given by $D_B' = 8.55 \times 10^{-10}$ exp-(17,800/RT) cm^3/sec for the polycrystals and $D_B' = 3.1 \times 10^{-11}$ exp-(11,800/RT) cm^3/sec for the ⟨100⟩ tilt bicrystals. The activation energy for the ⟨112⟩ tilt boundaries is significantly larger than that of the polycrystal boundaries or ⟨100⟩ tilt boundaries. The simultaneous diffusion of ^{105}Ag and ^{110}Ag in the grain boundaries of the polycrystals from 350 to 555°C and ⟨100⟩ tilt bicrystals at 400 and 498°C allowed for measurements of the isotope effect for grain boundary self-diffusion. The isotope effect results prove that there is very little isotopic separation during grain boundary diffusion. Within the experimental accuracies, the isotope effects for the random boundaries of the polycrystals and the ⟨100⟩ tilt boundaries are identical. The average value of $f_{\Delta}K$ for the polycrystals is 0.458. This is significantly lower than the low temperature lattice self diffusion isotope effect in silver. A vacancy model was developed from which the correlation factor for diffusion along dislocations can be calculated. This isotope effect measurements can be interpreted in terms of the modelistic calculations of the correlation factor and many-body saddle point interactions. The isotope effect measurements are consistent with a vacancy mechanism and a correlation factor substantially lower than the correlation factor for diffusion via vacancies in silver single crystals. Comparison of the isotope effect measurements with calculations of the correlation factor for diffusion via vacancies along dislocations shows that the maximum vacancy-dislocation binding energy is between 0.1 and 0.2 eV and decreases rapidly with distance from the dislocation core. Also, the assumptions of grain boundary widths on the order of two lattice parameters are consistent with this analysis. (Diss. Abstr. Int., B)

22610 COMPARISON OF THE HEAT OF ADSORPTION OF HYDROGEN AND DEUTERIUM ON NICKEL FILMS. Wedler, G.; Broecker, F. J.; Fisch, G.; Schroll, G. (Univ., Erlangen, Ger.). Z. Phys. Chem. (Frankfurt); 76: No. 3-4, 212-15(Nov 1971). (In German).

Nickel films of 100 Å thickness were condensed in ultrahigh vacuum at 10 Å/min. and 77°K. The heat of absorption for hydrogen varied considerably between individual films. Therefore, an isotope effect between hydrogen and deuterium could only be determined by direct calorimetric measurement on the same film. Each film was successively and alternatingly covered with small amounts of either hydrogen or deuterium. Under these conditions, the heat of absorption for deuterium was approximately 1 kcal larger than that for hydrogen. (H.B.G.)

22611 VARIATIONS OF HEAVY-ATOM KINETIC ISOTOPE EFFECTS IN SN2 DISPLACEMENT REACTIONS. Sims, L. B.; Fry, Arthur; Netherton, L. T.; (and others) (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3234. J. Amer. Chem. Soc.; 94: No. 4, 1364-5(23 Feb 1972).

Results from calculations of the kinetic isotope effects for the SN2 reactions of benzyl chloride are reported. Carbon-14 and ^{37}Cl isotope effects were calculated using the complete transition state theory expression. The chlorine isotope effect increases continuously from a reactant-like to a product-like transition state; however, bell-shaped curves were obtained for the ^{14}C isotope effect as a function of bond order. (D.H.M.)

22612 MICROWAVE SPECTRA, STRUCTURES, AND DIPOLE MOMENTS OF TRIMETHYLPHOSPHINE–BORANE AND METHYLPHOSPHINE–BORANE. Bryan, Philip S.; Kuczkowski, Robert L. (Univ. of Michigan, Ann Arbor). Inorg. Chem.; 11: No. 3, 553-9(Mar 1972).

The microwave spectra of four isotopic species of $(CH_3)_3P \cdot BH_3$ and nine isotopic species of $CH_3PH_2 \cdot BH_3$ were assigned. For $(CH_3)_3P \cdot BH_3$, the following structural parameters were determined: r(PB) = 1.901 ± 0.007 Å; r(PC) = 1.819 ± 0.010 Å; r(CH) = 1.08 ± 0.02 Å; r(BH) = 1.212 ± 0.010 Å; ∠CPC = 105.0 ± 0.4°; ∠HCH = 109.3 ± 1.0°; ∠HBH = 113.5 ± 0.5°. In deriving the structure, the methyl groups were assumed to be symmetric with a hydrogen–hydrogen distance of 1.760 Å. For $CH_3PH_2 \cdot BH_3$, the following structural parameters were determined: r(PH) = 1.404 ± 0.006 Å; r(PB) = 1.906 ± 0.006 Å; r(PC) = 1.809 ± 0.006 Å; $r(BH_s)$ = 1.234 ± 0.023 Å; $r(BH_a)$ = 1.229 ± 0.022 Å; $r(CH_s)$ = 1.087 ± 0.004 Å; $r(CH_a)$ = 1.098 ± 0.016 Å; $\angle H_aBH_s$ = 116.1 ± 0.8°; $\angle H_aBH_a$ = 112.3 ± 1.2°; $\angle H_sCH_s$ = 110.4 ± 0.6°; $\angle H_sCH_a$ = 108.1 ± 0.4°; ∠HPH = 99.9 ± 0.4°; ∠HPC = 103.2 ± 0.6°; ∠CPB = 115.7 ± 0.4°; ∠HPB = 116.3 ± 0.6°; $\angle PBH_s$ = 102.9 ± 0.6°; $\angle PBH_a$ = 104.2 ± 1.0°; $\angle PCH_s$ = 108.3 ± 0.4°; $\angle PCH_s$ = 111.3 ± 1.0°. The BH_3 and CH_3 groups were staggered with respect to the PH bonds. Dipole moments of 4.99 ± 0.2 D for $(CH_3)_3P \cdot BH_3$ and 4.66 ± 0.05 D for $CH_3PH_2 \cdot BH_3$ were obtained from Stark splittings. (auth)

22613 INFRARED SPECTROSCOPIC EVIDENCE FOR PALLADIUM TETRACARBONYL. Darling, J. H.; Ogden, J. S. (Oxford Univ.). Inorg. Chem.; 11: No. 3, 666-7(Mar 1972).

The infrared spectra obtained by the cocondensation of palladium atoms with $Ar-C^{18}O$ and $Ar-C^{16}O-C^{18}O$ are presented. (D.H.M.)

22614 ACID HYDROLYSIS OF p-NITROPHENYLDIAZOMETHANE IN H_2O–D_2O MIXTURES: ANALYSIS OF THE ISOTOPIC EFFECTS. Diderich, G.; Dahn, H. (Univ., Lausanne, Switzerland). Helv. Chim. Acta; 55: No. 1, 1-9(1972). (In French).

The velocity of the hydrogen ion-catalyzed hydrolysis of p-nitrophenyldiazomethane (I) was measured in H_2O-D_2O mixtures, giving an isotopic $\alpha_i = 0.49$. The product isotope effect $\gamma = 5.1$, determined from product analyses, combined with the (overall) solvent isotope effect $k_H/k_D = 2.81$, yields the primary kinetic isotope effect $(k_H/k_D)^I = 3.8$, and the secondary kinetic isotope effect $(k_H/k_D)^{II} = 0.75$. The $ClCH_2COOH$-catalyzed hydrolysis of I in H_2O-D_2O mixtures gave a straight-line plot of k_n/k_H versus the atomic fraction n of deuterium. With four carboxylic acids, as catalysts, values of about 4.3 for the kinetic (overall) isotope effects were observed. (auth)

22615 ISOTOPE EFFECT FOR SELF-DIFFUSION IN SINGLE CRYSTALS OF α IRON AND CORRELATION FACTOR OF SOLUTE DIFFUSION IN α IRON. Irmer, V.; Feller-Kniepmeier, M. (Technische Univ., Berlin). J. Appl. Phys.; 43: No. 3, 953-7 (Mar 1972).

The isotope effect in α-iron single crystals of different purity was determined to be $E_{778°C} = 0.43$ and $E_{901°C} = 0.46$. A dependence on crystal purity or temperature was not found. The correlation factor calculated can be interpreted by a single vacancy mechanism and/or an interstitialcy mechanism. The attempt to calculate the correlation factor for solute diffusion of copper in iron failed, because the diffusion data available in the literature were obtained with iron of different purity. (auth)

22616 VIBRATIONAL SPECTRA OF SiH_4 AND SiD_4–SiH_4 MIXTURES IN THE CONDENSED STATES. Fournier, R. P. (Laval Univ., Quebec); Savoie, R.; Nguyen Dinh The; Belzile, R.; Cabana, A. Can. J. Chem.; 50: No. 1, 35-42(1 Jan 1972).

The ir and Raman spectra of liquid and crystalline SiH_4 and SiD_4–SiH_4 mixtures were recorded. The spectra show striking changes when the crystal undergoes the solid–solid phase transition. Phase I is disordered. Possible site, and factor groups for the low temperature crystalline phase are proposed. (auth)

22617 DEUTERIUM ISOTOPE EFFECT IN OCTAHEDRAL SUBSTITUTIONS. VI. BASE HYDROLYSIS OF HALOGENOPENTAMMINERHODIUM(III) PERCHLORATES. Chan, S. C.; Chan, S. F. (Univ. of Hong Kong). J. Inorg. Nucl. Chem.; 34: No. 2, 793-6(Feb 1972).

The studies were undertaken in connection with investigations of nucleophilic octahedral substitutions. Base hydrolysis of the Rh complex using D_2O as solvent was compared with that using H_2O as solvent, employing spectrophotometric methods. Details

are given of the experimental method, and results are discussed. Rate constants and D isotope effect data are shown tabulated. (UK)

Isotope Exchange and Isotope Separation

22618 STUDY ON THE DEUTERATION OF AUTHENTIC HYDROCARBONS WITH D_3PO_4–BF_3 COMPLEX. Makabe, Masataka; Yokoyama, Susumu; Itoh, Mitsuomi; Takeya, Gen (Hokkaido Univ., Sapporo). Hokkaido Daigaku Kogakubu Kenkyu Hokoku; No. 62, 77-90(Sep 1971). (In Japanese).

Deuteration of pure hydrocarbons was attempted to gain additional information concerning the deuterium exchange reaction of coal and coal derivatives. Deuterophosphoric acid–boron trifluoride complex was used as the deuteration reagent for the authentic substances. The following pure hydrocarbons were used: aromatic ring substances, alkylbenzenes, and other saturated hydrocarbons. The analyses of deuterated products were carried out by various methods. Infrared spectroscopy, especially in the region of C–H and C–D stretching vibration, gave both qualitative and quantitative information. By mass spectroscopy the distribution of substituted deuteriums was measured. A high-resolution nuclear magnetic resonance study yielded highly important information on the quantitative substitution of each type of hydrogen. It was found that the deuteration of aromatic hydrocarbons occurred readily at 65°C in two hours, and aromatic hydrogens were deuterated up to 80% or more. The deuteration in the alkyl parts of the alkyl aryl hydrocarbons was observed only in the case of cumene and tetralin, and all aliphatic hydrocarbons were not substituted under the above conditions. In the case of cumene, disproportionation occurred after fifteen minutes from the onset of the reaction. It seems that the deuteration of the side chain of cumene occurred when its propyl carbonium ion was separated from the aromatic nucleus to cause disproportionation or transalkylation. (Japan)

22619 KINETICS OF HYDROGEN EXCHANGE REACTION STUDIED BY RADIOGASCHROMATOGRAPHIC PULSE TECHNIQUE. Kaminski, A. M.; Sobkowski, J. (Univ., Warsaw). Radiochem. Radioanal. Lett.; 9: No. 4, 269-74(4 Mar 1972).

A method for studying the isotope exchange reaction of hydrogen between methane and hydrogen molecules in the gas phase, using radiogaschromatographic and pulse techniques, is described. (auth)

22620 LABORATORY ENRICHMENT OF HEAVY WATER BY ELECTROLYSIS. PART II. EFFECT OF CURRENT DENSITY, CATHODE MATERIAL, AND TEMPERATURE ON THE SEPARATION FACTOR. Hallaba, E.; Aly, A. I. M. (Atomic Energy Establishment, Cairo). Isotopenpraxis; 7: No. 11-12, 456-9 (Nov-Dec 1971).

Different parameters affecting electrolytic H-D separation factor were investigated. The separation factor α increased with current density and then attained a constant value. With different cathodes α increased in the following way: phosphated iron > iron > stainless steel > nickel. It was found that α decreased as the temperature increased. By applying the Arrhenius equation it was possible to calculate the difference in the free energy of activation for proton and deuteron transfer using different cathodes. Excessive reduction in the volume of electrolyte lowered the separation factor. No marked effect on α was observed by changing the type or concentration of electrolyte. (auth)

22621 EFFECT OF ADSORPTION OF CARRIER GAS IN GAS–SOLID CHROMATOGRAPHY: THEORY AND ITS APPLICATION TO THE SEPARATION OF HYDROGEN ISOTOPES. Sato, Toshio; Ohkoshi, Sumio; Takahashi, Tomiki (Government Industrial Development Lab., Sapporo). J. Chromatogr.; 65: No. 2, 413-24 (23 Feb 1972).

Analytical formulas to express the effect of adsorption of carrier gas in gas–solid chromatography were derived from the theory of nonlinear ideal chromatography and the Langmuir adsorption theory. They predict improvement of symmetry in peak shape, reduction in retention volume, independence of relative retention on the kind of carrier gas used, and the smaller dependence of retention volume on column temperature when an inert gas is replaced with an adsorptive gas as carrier. The formulas were satisfactorily applied to explain experimental results on the separation of hydrogen isotopes by a series of ammonia-treated molecular sieve 13X columns. (auth)

22622 LABORATORY ENRICHMENT OF HEAVY WATER BY ELECTROLYSIS. PART I. DESIGN OF ELECTROLYTIC CELLS AND CALCULATION OF THE MEAN CURRENT DENSITY. Hallaba, E.; Aly, A. I. M. (Atomic Energy Establishment, Cairo). Isotopenpraxis; 7: No. 10, 427-30(Oct 1971).

The cylindrical cell design was found suitable for deuterium enrichment of relatively large volumes of water. The perforation of the anode helped in the free and rapid liberation of the gases. The second plate type design was more suitable for enrichment in small volumes. The mean current density of the first and second cell necessary for the study of the separation factor was derived. (auth)

22623 BASE-CATALYZED DEUTERATION OF TRICARBONYLCHROMIUM COMPLEXES. Ashraf, M. (Queen's Univ., Belfast). Can. J. Chem.; 50: No. 1, 118-21(1 Jan 1972).

Hydrogen–deuterium exchange in tricarbonylchromium complexes of anisole, ethylbenzoate, and N,N-dimethylaniline was studied for solutions in ethanol-O-d_1, containing sodium ethoxide. The extent of deuteration was estimated mass spectroscopically and the position of deuteration by nmr spectroscopy. In this kinetically controlled reaction ortho-substitution was found to be predominantly preferred in case of anisole complex, whereas random substitution was observed (nmr) for ethylbenzoate complex. The results are interpreted in terms of chelative, inductive, mesomeric, and steric effects of the substituents. (auth)

22624 DETERMINATION OF THE ACTIVATION ENERGY OF THE $^{15}N/^{14}N$ ISOTOPIC EXCHANGE REACTION BETWEEN NITRIC OXIDE, NITROGEN DIOXIDE, AND NITRIC ACID. II. Axente, D.; Piringer, O. (Inst. for Stable Isotopes, Cluj). J. Inorg. Nucl. Chem.; 34: No. 3, 847-51(Mar 1972).

The rate constants of the isotopic exchange reactions that form the basis of the ^{15}N isotopic separation by the Spindel–Taylor method (J. Chem. Phys. 33: 981(1955)) were determined in the temperature range 16 to 55°C. From the data obtained, the entropy and enthalpy of activation were calculated. The isotopic exchange mechanism between nitrogen oxides and dilute solutions of nitric acid is discussed. (auth)

Radiation Chemistry

Refer also to abstracts 22576, 23253, 23677, 24670, and 24693.

22625 (NP-19191) RADIATION CHEMISTRY OF MESO-ERYTHRIT IN AQUEOUS SOLUTION. Dizdaroglu, Miral (Karlsruhe Univ. (West Germany)). [1971]. 114p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

A reaction scheme is proposed for the formation of products of radiolysis of meso-erythritol. The water radicals formed by γ radiolysis (90% OH and 10% H) attack with equal probability the C-atom 1 and C-atom 2. The primary radicals then either react with other radicals or transform into secondary radicals through split-off of water. Dimers originate predominantly from combination reactions of secondary radicals. Erythrose and erythrulose, as products of radiolysis, are formed by reactions of primary radicals. The secondary radicals lead to 2-desoxytetrose, 1,4-dihydroxy-2-butanone, and 3,4-dihydroxy-2-butanone. Through β-elimination, primary radicals form glyceraldehyde. (H.B.G.)

22626 STRUCTURE AND RADIOLYSIS OF CONCENTRATED NITRATE SOLUTIONS. Kiwi, John Tichauer. Corvallis, Oreg.; Oregon State Univ. (1972). 279p. University Microfilms Order No. 71-31,108.

Thesis.

Studies of the structure of the concentrated nitrate solutions were carried out to determine the hydration and ion complex behavior of $LiNO_3$, KNO_3, $NaNO_3$, $CsNO_3$, $Ca(NO_3)_2$, $(CH_3)_4NNO_3$, and NH_4NO_3. Near infrared absorption spectroscopy was carried out over a wide concentration range for each of these solutes. Proton nuclear magnetic resonances were measured over a range of temperatures for different concentrations of each solute. The hydration values obtained for a given concentration of a specific salt do not generally agree when determined by these two different methods. Concentrated solutions of lithium, potassium, sodium, cesium, and calcium nitrates were irradiated in a ^{60}Co γ source. The values of $G(NO_2^-)$, $G(H_2O_2)$, $G(O_2)$, and $G(H_2)$ are reported as a function of concentration. The gas values are tentative in nature due to the difficulties experienced in the experiments. In spite of this fact an interpretation of the products of radiolysis has been carried out based on the electronic fractionation model for the absorption of energy. (Diss. Abstr. Int. B) (TSS)

22627 OPTICAL BLEACHING EFFECTS ON THE PARAMAGNETIC RELAXATION OF TRAPPED ELECTRONS IN METHYLTETRAHYDROFURAN AT 77°K. Lin, D. P.; Kevan, Larry (Wayne State Univ., Detroit). Contract AT(11-1)-2086. J. Phys. Chem.; 76: No. 5, 636-9(2 Mar 1971).

The effect of optical bleaching on the characteristic relaxation time, $(T_1T_2)^{1/2}$, of trapped electrons (e_t^-) in methyltetrahydrofuran (MTHF) glass at 77°K was measured for different doses corresponding to different initial spatial distributions. At low radiation doses $(T_1T_2)^{1/2}$ increases as e_t^- are bleached. This confirms the spur model of electron trapping in this matrix and indicates that the spurs contain more than one e_t^- on the average. At high radiation doses $(T_1T_2)^{1/2}$ remains constant as e_t^- are bleached. This is interpreted in terms of spin-spin relaxation of e_t^- with MTHF as well as with other e_t^-. A quantitative treatment of T_1T_2 data vs total spin concentration confirms this latter interpretation. (auth)

22628 INVESTIGATION OF CHAIN REACTIONS AND OXYGEN EFFECTS DURING RADIOLYSIS OF PEPTIDE DISULFIDE BONDS USING CYSTEINE-GLUTATHIONE DISULFIDE AS A MODEL. Purdie, J. W. (National Research Council of Canada, Ottawa). Radiat. Res.; 48: No. 3, 474-83(Dec 1971).

Gamma-radiolysis of cysteine-glutathione disulfide, the mixed disulfide of cysteine and the tripeptide glutathione, was examined in unbuffered aqueous solutions (0.3 mM). In the presence of air the principal products are sulfinic and sulfonic acids of cysteine and glutathione and the symmetrical disulfides, cystine and glutathione disulfide. In the absence of air, cysteine, glutathione, and the sulfinic acid derivatives of these thiols were produced in moderate yields whereas the symmetrical disulfides were both formed in very high yields (G ~ 10). Irradiation of solutions containing various concentrations of mixed disulfide and a range of oxygen concentrations showed that the high yields of symmetrical disulfides were due to a chain reaction which could be suppressed by oxygen. The following reactions were proposed: $RS\cdot + RSSR' \rightleftharpoons RSSR + R'S\cdot$ and $RS\cdot + O_2 \rightarrow RSO_2$. The results resembled those obtained using cysteine-cysteamine disulfide although the chain reaction appeared to be less efficient. It seems likely that in the case of larger peptides and proteins, radiation induced chain reactions may occur but the probability of such reactions would depend very much on the number and location of thiols and disulfides in the molecule. Further, oxygen should suppress thiyl radical chain reactions, especially intermolecular reactions, and result in formation of sulfinic and sulfonic acid derivatives. (auth)

22629 PROCESS FOR THE RADIATION GRAFTING OF BUTADIENE AND OTHER CO-GRAFT MONOMERS ONTO POLYOLEFIN SUBSTRATES. Gotohda, Masao; Araki, Kunio; Imamura, Shigeoshi; Shibabe, Sadami (to Japan Atomic Energy Research Inst.). U. S. Patent 3,634,218. 11 Jan 1972. Filed 31 Oct 1967.

A process is presented in which a polyolefin is brought into contact with butadiene and styrene and/or acrylonitrile in the gaseous or liquid phase, either during or subsequent to irradiation of the polyolefin with an ionizing radiation whereby graft polymerization of the butadiene and cograft monomer is effected onto the polyolefin. (auth)

22630 RADIATION CHEMISTRY OF ICOSAHEDRAL CARBORANE CONDENSED PHASES: 1-VINYL- AND 1-ISOPROPENYL-o-CARBORANE. Wright, John Ricken. University, Miss.; University of Mississippi (1971). 113p. University Microfilms Order No. 72-3939.

Thesis.

The ^{60}Co γ induced reactions of bulk 1-vinyl- and 1-isopropenyl-o-carborane were examined between 0 and 175°C. One-vinyl-o-carborane yielded a short-chain vinyl addition polymer structurally analogous to polystyrene ($\overline{DP}_n$ ~ 5; G(-m) = 35 molecules/100 eV at 31°C). This structural assignment was based on uv, ir, ^1H-, and ^{11}B-NMR and mass spectroscopic evidence. It was found that the ^1H-NMR spectra of carborane polymer solutions may undergo modifications at reduced temperatures, i.e., the 1:1:1:1 quartet due to one-bond ^{11}B-^1H coupling may collapse to a singlet, most probably as a result of spin decoupling via rapid ^{11}B nuclear spin relaxation. In the case of radiolytically polymerized 1-vinyl-o-carborane, a partial collapse of the quartet was observed in pyridine or quinoline solutions at 37°C, and the ratio of singlet to quartet resonance was an inverse function of temperature. Yields from 1-isopropenyl-o-carborane were principally two dimeric addition products in a solid state reaction [G(-m) ~ 100 molecules/100 eV at 31°C]. The more abundant dimer, about 70% of the total product, was assigned a head-to-head linkage involving the isopropenyl group. Pure 1-isopropenyl-o-carborane was a birefringent, crystalline solid below its capillary melting point of 47°C, but 1-vinyl-o-carborane was found to be plastic crystalline between 11°C and its capillary melting point of 79°C. The latter compound's mesomorphic properties were revealed chiefly through x-ray diffraction, dta, ^1H-NMR linewidth and observations with a polarizing microscope. At 25°C the lattice was face-centered cubic with a lattice constant of 10.6 Å. The plastic crystalline state of aggregation of this monomer was characterized by polymerization dynamics similar to those of the liquid state since a plot of $\log_{10}$ G(-m) versus 1/T was linear over a 175°C range and continuous within the experimental error at the capillary melting point. Radiolysis yields for 1-isopropenyl-o-carborane, however, were considerably reduced above the melting point, leading to a discontinuous Arrhenius-type plot of G(-m) values. The major product of the solid state reaction was not detected in liquid state radiolysates. The experimental activation energy for the 1-vinyl-o-carborane polymerization was 3.3 kcal/mole, which must be regarded as a lower limit since the exponent of the dose rate dependence of R_p was 0.76. Supporting scavenger experiments in the liquid state of the pure monomer revealed that G(-m) was essentially unaffected by electron scavengers, increased by methanol and decreased by α-pinene and diethyl sulfide. These preliminary findings favor an initiation by hydrogen atoms, but ionic processes cannot be ruled out. The nature of the reactions occurring in solid 1-isopropenyl-o-carborane are even more obscure, but the confinement of the chain dimerization to the crystalline state suggests that the reaction is influenced by the lattice periodicity. Comparative thermochemical studies produced no insight into these radiolytic reactions, but evidence was obtained which tentatively suggests that the monomers may enter electron transfer reactions with phenyl lithium. (Diss. Abstr. Int., B)

22631 AGING OF SPIRITOUS PRODUCTS. Ueno, Teruo (Radiation Center of Osaka Prefecture, Sakai, Japan). Koryo; No. 98, 21-6(Mar 1971). (In Japanese).

The physical and chemical changes of spirituous products during aging are reviewed and the physical methods of accelerated aging are summarized. The effects of γ-irradiation on wine and spirituous beverages are also described. (Japan)

22632 EARLY STAGES OF RADIATION-PRODUCED CHARGE CARRIERS. Schiller, Robert (Central Research Inst. for Physics, Budapest). Curr. Top. Radiat. Res.; 6: 1-50 (1970).

The fate of radiation-produced ions and electrons after they have been thermalized is discussed. After this stage is reached, the electron may be recaptured by its parent ion, captured by a radiation-produced ion other than its parent, captured by a scavenger, trapped in the matrix, or solvated. Bulk and initial recombination, preferential recombination in nonpolar systems, and recombination in dipolar systems are discussed. (114 references). (M.C.G.)

22633 BROMINE DIOXIDE: SPECTROSCOPIC IDENTIFICATION OF RADICALS. Bossy, J. M.; Leoni, M. W.; Buehler, R. E. (Eidgenoessische Technische Hochschule, Zurich). Helv. Chim. Acta; 55: No. 1, 107-16(1972). (In German).

Pulse radiolysis of oxygen-saturated bromobenzene yields a transient absorption with λ_{max} = 480 nm at pulse end, which is identified as due to the BrO_2 radical. To confirm this assignment the same radical was produced by flash photolysis of a Br_2–O_2 gas mixture and by chemical synthesis at low temperature. The absorption spectra of these BrO_2 samples present a maximum between 480 and 380 nm dependent on the solvent. The influence of complex-formation on this absorption is discussed. The ESR spectrum of chemically synthesized BrO_2 is given. (auth)

22634 CORRELATED DIFFUSION-CONTROLLED KINETICS. Peak, D.; Frisch, H. L.; Corbett, J. W. (State Univ. of New York, Albany). Radiat. Eff.; 11: No. 3-4, 149-54(Dec 1971).

The theory of diffusion-limited bimolecular reaction kinetics was investigated for the case in which the reactants are initially produced in spatially correlated pairs. The intent of the study is to discover to what extent information concerning the initial distribution of pair member separations (generally unknown for such systems) can be deduced from empirically observable quantities. The analysis predicts the form of the dependence of the fractional concentration of recombined pairs on various moments of the distribution function as well as the approximate concentration dependence of very late time correlated reactions. It is expected that the model may be applicable to many systems in radiation- and photo-physics, chemistry, and biology; specific examples of radical reactions in solution and the annealing of damage produced by electron irradiation of metals and semiconductors are discussed. (auth)

22635 STUDIES IN RADIATION-INDUCED POLYMERIZATION OF VINYL MONOMERS AT HIGH DOSE RATES. I. STYRENE. Squire, D. R.; Cleaveland, J. A.; Hossain, T. M. A.; (and others) (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 16: No. 3, 645-61(Mar 1972).

The kinetics and degree of polymerization of the electron and γ radioinduced polymerization of styrene were investigated at dose rates up to 3 Mrads per sec. It was found that both the polymer-

ization rates and the molecular weights at high dose rates lie well above the values predicted by extrapolation from low dose rate studies where the mechanism is primarily free radical in nature. The evidence obtained indicates that with increasing dose rate there is an increase in the ionic contribution to the polymerization mechanism. At the highest dose rates investigated, 3 Mrads per sec, the ionic mechanism dominates while the free-radical mechanism contributes insignificantly. There was no inhibition of the polymerization of styrene by dissolved air at the higher dose rates. Investigation of the polymerization of styrene saturated with water tends to support the ionic mechanism via free cations. Investigations of equimolar solutions of styrene and methyl methacrylate further support the ionic mechanism, yielding predominately polystyrene and a small amount of 50–50 copolymer. In the intermediate dose rate range, 1000 rads per sec, there is evidence that the high dose rate free-radical kinetic mechanism is the principal mechanism. (auth)

22636 DETERMINATION OF THE MOLECULAR WEIGHT DISTRIBUTION OF POLYISOPRENE BY RANDOM SCISSION. Booth, C.; Harlan, J. T. (Shell Chemical Co., Torrance, Calif.). J. Appl. Polym. Sci.; 16: No. 3, 551-8(Mar 1972).

Dilute solutions of cis-polyisoprene in toluene (plus antioxidant) undergo random scission when exposed to γ-radiation. The possibility of using this scission in a method to assess the width of the molecular weight distribution of the polymer was explored and found potentially useful in situations where conventional methods provide little information. (auth)

22637 KINETICS AND MECHANISM OF LOW-TEMPERATURE RADIATION-INDUCED POSTPOLYMERIZATION OF BUTYL METHACRYLATE IN THE PRESENCE OF ZINC CHLORIDE. Georgiev, G. S.; Kaplan, A. M.; Zubov, V. P.; (and others) (Moscow State Univ.). Vysokomol. Soedin., Ser. A; 14: No. 1, 177-85(Jan 1972). (In Russian).

Slow defreezing of a butyl methacrylate (BMA) complex with $ZnCl_2$ (the mole fraction of zinc chloride = 0.41) irradiated with γ rays at −196° was carried out. Above −100° polymerization proceeds to high conversion degrees. Under similar conditions postpolymerization of pure BMA practically does not occur. On the strength of the experimental data obtained by calorimetry and ESR, the process can be assumed to occur by the radical mechanism. Fast postpolymerization of the BMA complex occurs above the glass transition temperature of the complex, with constant active centers concentration. The polymers obtained are characterized by a narrow molecular weight distribution. The chain propagation constant of BMA was determined for the low-temperature polymerization of its complex with $ZnCl_2$. (auth)

22638 PHOTOLYSIS AND RADIOLYSIS OF CHLORAMPHENICOL. Reisch, J.; Weidmann, K. G. (Univ., Muenster, Ger.). Arch. Pharm.; 304: No. 12, 911-19(Dec 1971). (In German).

In aqueous solution chloramphenicol undergoes decomposition into an aromatic (I) and an aliphatic (II) radical through photo-β-cleavage. I stabilizes itself to p-nitrobenzaldehyde, II to glycol aldehyde and dichloroacetamide. Through a sequence of photosensitized and nonphotosensitized reactions, p-nitrobenzaldehyde is reduced to p,p′-azoxybenzoic acid, p-aminobenzaldehyde and p-amino-benzoic acid; through "oxygen quenching" it undergoes oxidation, mainly to p-nitrobenzoic acid. In presence of 1,3-butandiol the primarily formed p-nitrobenzaldehyde is transformed to 2-(p-nitrophenyl)-4-methyl-1,3-dioxane. If aqueous chloramphenicol solutions are subjected to γ-rays, degradation products similar to those produced through photolysis are formed. Chloramphenicol is more stable in the crystalline state; also here photo-induced β-cleavage takes place to a limited extent. (auth)

22639 ELECTRON SPIN RESONANCE OF γ-IRRADIATED TAURINE. Lind, G.; Kewley, R. (Queen's Univ., Kingston, Ont.). Can. J. Chem.; 50: No. 1, 43-9(1 Jan 1972).

The 9.5 GHz electron spin resonance (ESR) spectra of single crystal and powder samples of γ-irradiated taurine, $H_3\dot{N}CH_2CH_2SO_3^-$, were recorded. Overlapping spectra from three distinct radicals are present. The first of these is the species SO_3^- with an isotropic g-value of 2.0035 and a ^{33}S hyperfine coupling tensor with principal values 135.2, 99.2, and 97.9 G. The second radical is a π-electron species with the unpaired electron mainly on carbon and exhibiting hyperfine interaction from at least four protons, probably $H_3\dot{N}CH_2CH_2$ or $H_3\dot{N}CH_2CHSO_3^-$, and with principal g-values 2.0021. 2.0027, and 2.0034. The third radical has principal g-values 2.0024, 2.0056, and 2.0097 and principal values of the ^{33}S hyperfine tensor of 49.6, 9.1, and 1.2 G. The proposed structure for this radical is $H_3\dot{N}CH_2CH_2SO_2$. (auth)

22640 PULSED RADIOLYSIS AND POLAROGRAPHY. pH-DEPENDENCE OF THE OXIDATION-REDUCTION POTENTIALS OF SHORT-LIVED ORGANIC RADICALS ON THE DROPPING MERCURY ELECTRODE. Graetzel, M.; Henglein, A.; Lilie, J.; Scheffler, M. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 76: No. 1, 67-72(Jan 1972). (In German).

The polarographic curves of the radicals $CH_3\dot{C}HOH$, $\dot{C}H(OH)_2$, $CH_3\dot{C}HOC_2H_5$, $\dot{C}H_2COOH$, $\dot{C}_6H_5OH$, $\dot{C}H_2C(CH_3)_2OH$, and $CH_3\dot{C}HC(CH_3)_2OH$ were measured at different pH values of the aqueous solutions. In many cases, the position of the reduction wave in alkaline solution is independent of the pH value. In acid solutions, however, the wave is shifted towards more positive potentials with decreasing pH. The wave for oxidation often shows a reverse dependence. The C_6H_5OH radical is distinguished by its pH independent oxidation and reduction waves. A similar behavior by the $CH_3CHOC_2H_5$ radical was found. The question of the reversibility of the processes occurring at the electrode is discussed and mechanisms are proposed that qualitatively explain the observed effects. (auth)

22641 KINETIC INVESTIGATION OF THE IODINE–AMYLOSE REACTION BY PULSED RADIOLYSIS. Graetzel, M. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Henglein, A.; Scheffler, M.; Boessler, H. M.; Schulz, R. C. Ber. Bunsenges. Phys. Chem.; 76: No. 1, 72-81(Jan 1972). (In German).

Aqueous solutions of amylose containing 10^{-3}M KI and 2.5×10^{-2}M N_2O were irradiated with a short pulse of high-energy electrons for 1 to 30 microseconds. The reaction of the iodine formed during the pulse with the amylose solution was followed by recording the increase in the optical absorption in the range from microseconds to tenths of seconds. The initial rate of the reaction as measured by the initial rate of increase in extinction at 6000 Å is proportional to the fourth of fifth power of $[I_2]$ at low iodine concentrations of some 10^{-6} M. The reaction is of first order with respect to $[I_2]$ at high iodine concentrations of about 10^{-4}M. At low as well as high iodine concentration, the rate is proportional to the concentration of amylose. The increase in rate with amylose concentration is smaller, however, at a medium iodine concentration of about 10^{-5}M. The form of the absorption spectrum does not change during the reaction if the concentration of iodine is low. A small redshift of the absorption maximum was observed at high iodine and low amylose concentrations. A strong redshift occurred at high amylose and medium iodine concentrations. These effects are explained starting with a mechanism proposed by Thompson and Hamori. The equilibrium between free iodine and iodine bound within the helical segments of amylose is at first rapidly attained. In this equilibrium, complexes up to three I_2 molecules per helix exist. An average association constant of $3.3 \times 10^4 M^{-1}$ for the equilibria $H_0 + I_2 \rightleftharpoons H_1$, $H_1 + I_2 \rightleftharpoons H_2$, $H_2 + I_2 \rightleftharpoons H_3$ was derived from the kinetic measurements (H_n: helix segment containing n I_2 molecules). At low iodine concentrations, the Thompson–Hamori mechanism is suitable for explaining the observed effects. Under these conditions, the rate of growth of complexes by successive uptake of I_2 molecules is much higher than the rate of chain initiation. The rate of initiation, however, is high at high iodine concentrations and is independent of $[I_2]$ so that the overall rate of the reaction is solely determined here by the rate of propagation. The rate constant of I_2-uptake decreases with increasing number of I_2 molecules already contained in a helix. It is equal to about $3.3 \times 10^8 M^{-1}\ s^{-1}$ for the uptake of the sixth and about $1.0 \times 10^8 M^{-1}\ s^{-1}$ for the uptake of the seventh I_2 molecule. The rate of initiation is also high at high concentrations of amylose. The chain growth, however, is now strongly restrained because of the fast initial consumption of iodine. The started chains therefore grow slowly and nearly simultaneously. (auth)

22642 ISOTOPE EFFECTS AND HYDROGEN YIELDS IN THE RADIOLYSIS OF H_2O–D_2O MIXTURES AT VERY HIGH DOSE RATES. Boyd, A. W.; Willis, C.; Lalor, G. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem.; 50: No. 1, 83-92(1 Jan 1972). (AECL–4047).

Total hydrogen yields and their isotopic ratios were measured in the single pulse, high dose rate radiolysis of H_2O–D_2O mixtures and acidic, basic, and nitrous oxide solutions. The yield from D_2O is ~11% lower than in H_2O at 7×10^{27} eV $g^{-1}\ s^{-1}$. In acid solutions the yields from H_2O and D_2O are the same within 5%. This yield, $G(H_2) = 1.15 \pm 0.5$, was used to derive a value of $k_{H+OH} = 2.5 \pm 0.3 \times 10^{10}\ M^{-1}\ s^{-1}$. Using the literature values for primary yield data and for the reaction rate constants, values of α were determined for the various hydrogen forming processes by computer calculation. Values for hydrogen formation of $\alpha_{spur} = 2.1 \pm 0.1$, $\alpha_{e+e} = 6.0 \pm 0.1$, α_{H+H} (effective) $= 3.2 \pm 0.1$, and α_{e+H} (effective) $= 1.3 \pm 0.2$ were obtained. Detailed consideration of

the mechanisms involved suggests that there are little or no isotopic preferences in H + H and e + H reactions. (auth)

22643 RATES OF HYDRATED ELECTRON REACTIONS WITH UNDISSOCIATED CARBOXYLIC ACIDS. Micic, O. I.; Markovic, V. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Int. J. Radiat. Phys. Chem.; 4: No. 1, 43-9(Feb 1972).

The rate constants for the reaction series RCOOH + e^-_{aq}, with different substituents R (H, CH_3, C_2H_5, CHO, CH_2OH, CH_3CHOH, C_6H_5, CH_2COOH, $(CH_2)_2$, COOH, CH_2COO^-) were determined by steady-state competition kinetics. The competing reaction was the reaction of the hydrated electron with the hydronium ion. The effect of the substituents on the rate constants was shown to be mainly of the inductive type. The reaction rates can be correlated by means of Taft's equation with positive slope $\rho^* = 1.94 \pm 0.15$. As expected, significant deviations were observed in cases in which interactions other than inductive are possible. H atoms are not formed in these reactions. In the case of formic, acetic, and propionic acids reactions proceed in two paths at comparable rates, and H atoms are formed as a product in one of them. (auth)

22644 RATE OF REACTION OF SOLVATED ELECTRONS WITH HYDROGEN IONS IN METHANOL. Baxendale, J. H. (Univ. of Manchester, Eng.). Int. J. Radiat. Phys. Chem.; 4: No. 1, 113-15(Feb 1972).

The reaction rate constant for $e_s^- + H^+$ in methanol at 20 (±2)°C was redetermined and found to be 5.2×10^{10} dm^3 mol^{-1} s^{-1} with an experimental scatter of ±4 percent. (auth)

22645 STRUCTURE OF THE HYDRATED ELECTRON SPECTRUM IN ALKALINE SOLUTIONS. Kabakchi, S. A.; Shubin, V. N. (Inst. of Electrochemistry, Moscow). Int. J. Radiat. Phys. Chem.; 4: No. 1, 1-10(Feb 1972). (In Russian).

The spectra of hydrated electrons formed in basic solutions at concentrations between 0.1 and 17.5 mol dm^{-3} are analyzed from the viewpoint of the theory of localized centers. Several bands are superimposed in the range 11.1 to 2.08×10^4 cm^{-1}. The spectrum comprises a main band, the position of its maximum moving from 1.46×10^4 to 1.56×10^4 cm^{-1} as the solute concentration varies from 1 to 14.5 mol dm^{-3}, and additional bands with $\nu^2_{max} = 2.02 \times 10^4$ cm^{-1} and $\nu^3_{max} = 1.28 \times 10^4$ cm^{-1}; these last positions are independent of the alkali concentrations. At 14.5 mol dm^{-3} an extra band with $\nu^4_{max} = 1.20 \times 10^4$ cm^{-1} appears. In neutral and 0.1 mol dm^{-3} solutions the bands corresponding to ν^3_{max} and ν^4_{max} were not observed. The bands with ν^1_{max} and ν^2_{max} disappear in the interval 0–20 μs by a second order process with a constant $2k_{II}/\epsilon l = 1.5 \times 10^3$ s^{-1}, and those with ν^3_{max} and ν^4_{max} by a first order process with a constant $k_I = 9.2 \times 10^4$ s^{-1}. It is proposed to attribute the bands corresponding to ν^1_{max} and ν^2_{max} to one particle, the hydrated electron, and those with ν^3_{max} and ν^4_{max} to another, which only appears in strongly alkaline solutions. The identity of this latter particle is discussed. (auth)

22646 X-IRRADIATION OF AQUEOUS SOLUTIONS OF ETHYLENEDIAMINETETRAACETIC ACID (EDTA). Bhattacharyya, S. N.; Kundu, K. P. (Saha Inst. of Nuclear Physics, Calcutta). Int. J. Radiat. Phys. Chem.; 4: No. 1, 31-41(Feb 1972).

Aqueous solutions of EDTA at different pH were irradiated with x rays both in the presence and in the absence of dissolved oxygen. The radiolytic yields for the decomposition of EDTA and the formation of H_2O_2 and carbonyl compounds were determined. A radiolytic mechanism is proposed and discussed in the light of the observed results. From competition kinetic studies with CH_3OH in neutral solution the rate constant k(OH + EDTA) was found to be 2.76×10^8 dm^3 mol^{-1} s^{-1}. (auth)

22647 ELECTRON DIFFRACTION STUDY OF RADIATION DAMAGE IN CORONENE. Claffey, W. J.; Parsons, D. F. (Roswell Park Memorial Inst., Buffalo). Phil. Mag.; 25: No. 3, 637-43(Mar 1972).

The problem of radiation damage to the specimen in the electron microscope is discussed from a study of the deterioration of the electron diffraction pattern of coronene. The damage was found to decrease linearly as a function of accelerating voltage to 200 keV. It is estimated that about three inelastic interactions for every four carbon atoms is sufficient to cause substantial damage at high resolution; the implications of this result for molecular microscopy are considered. A calibration technique for electron detectors is introduced. (auth)

22648 ESR STUDIES OF IRRADIATED CELLULOSE ACETATE. Deffner, Ulrich; Paretzke, Herwig (Gesellschaft fuer Strahlen- und Umweltforschung, Neuherberg, Ger.). Radiat. Res.; 49: No. 2, 272-7(Feb 1972).

It is shown by ESR investigation, that in γ-irradiated cellulose triacetate at 77°K, several kinds of radicals are produced, which decay approximately according to a second order law at higher temperatures. After uv-irradiation, mainly methyl radicals are generated. They have a very short lifetime at room temperature. Irradiation at room temperature with uv or γ rays results in the same type of radicals. (auth)

22649 RADIOTHERMOLUMINESCENCE IN 10 M KOH SOLUTIONS. Sultankhodzhaeva, M. N.; Sharpatyi, V. A. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 5, 1152-5(11 Oct 1971). (In Russian).

Low-temperature radiolysis of alkali solutions was carried out in the presence of "fragments" of nucleic acids, using 0.25 to 14 MR of ^{60}Co γ radiation. Solutions of KOH (10 M) containing glucose and thymine were thus irradiated at 77°K and allowed to warm. Between 100 to 185°K luminescence was observed: two maxima at approximately 112° and 167°K. Storage of the irradiated samples for 32 days in liquid nitrogen caused lessened light production upon warming. Possible mechanisms are discussed. (K.S.W.)

22650 SPECTROSCOPIC STUDY OF THE ACTION OF INORGANIC PEROXIDES AND γ RADIATION ON THE ARYLMETHANE DYE RHODAMINE C. Ereshchenko, A. G.; Stepantsova, N. P.; Geller, B. E. Zh. Prikl. Spektrosk.; 15: No. 3, 486-90(Sep 1971). (In Russian).

During a study of the effects of γ radiation (from ^{60}Co), H_2O_2, and $K_2S_2O_8$ on aqueous solutions of rhodamine C, a portion of the dye was observed to precipitate. The ir absorption spectrum of this precipitate possessed the same bands that characterized the system of conjugated bonds of the parent substance: at 1,608, 1,352, and 1,180 cm^{-1}. A decrease in intensity of the C—H vibration bands (2,865 and 2,930 cm^{-1}) was noted. A mechanism involving free radical forms of the dye that combined with each other is suggested. (tr-auth)

22651 RADIOLYSIS OF AQUEOUS SOLUTIONS OF SOME ORGANIC MONOPHOSPHATES. Kochetkov, N. K.; Kudryashov, L. I.; Chlenov, M. A.; Grineva, L. P. (Inst. of Organic Chemistry, Moscow). Zh. Obshch. Khim.; 41: No. 9, 2071-6(Sep 1971). (In Russian).

Aqueous solutions (0.2M) of disodium salts of cyclohexyl phosphate, D-glucose-6-phosphate, and the dipotassium salt of α-D-glucose-1-phosphate were subjected to γ radiation from a ^{60}Co source. Paper chromatography and electrophoresis were used in determining the yields of decomposition products and of inorganic phosphate. The OH radical was found to play a major role in radiation dephosphorylation. Glucose was not among the products formed along with inorganic phosphate. Among the decomposition products from glucose phosphates were a reducing sugar and desoxy- and desoxyketo sugars. (K.S.W.)

22652 FOTOKHIMICHESKIE I RADIATSIONNO-KHIMICHESKIE PROTSESSY V VODNYKH RASTVORAKH I TVERDYKH TELAKH. (Photochemical and Radiation Chemistry Processes in Aqueous Solutions and Solid Bodies). Sviridov, V. V.; Shagisultanovoi, G. A. (eds.). Minsk; Izdatel'stvo BGU im V. I. Lenina (1970). 192p.

This collection of 21 papers by various authors deals with the effects of light (Hg-vapor lamps), uv, and γ radiation on a variety of pure chemical substances and their solutions, argine and lysine being the only materials of a wholly organic nature included. The inorganic compounds reviewed for radiation and photolysis effects are silver oxalates, mercury selenoiodide ($Hg_3Se_2I_2$), Ag_2C_2, MnO_4^- and SO_3^{2-} ions, and numerous complexes of Co, Fe, Mn, Pt, Cr, and Cu. Much of the work described was performed on frozen solutions (77°K). The results are discussed in the light of contemporary concepts of high-energy chemistry, intra- and intermolecular processes of phototransfer in solutions of inorganic complexes. (K.S.W.)

22653 MOLECULAR POLARIZABILITY AS A BASIS FOR ENERGY PARTITIONING ESTIMATES IN ORDINARY RADIOLYSIS. Lucas, L. L.; Root, J. W. (Univ. of California, Davis). Chem. Phys. Lett.; 13: No. 1, 65-9(1 Feb 1972).

Independent assessments of relative energy depositions in mixtures based on low-velocity proton stopping cross sections or upon radiolytic ionization yields suggest that the effective energy deposition during radiolysis is proportional to molecular polarizability. The results indicate that energy partitioning estimates based on the Simple Mixture Law will be grossly inaccurate in systems containing halocarbons or rare gases. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 22600 and 22776.

22654 COMPARATIVE MOESSBAUER STUDY OF THE CHEMICAL AFTER-EFFECTS OF ^{57}Co EC AND ^{119m}Sn IT DECAYS. Friedt, J. M.; Llabador, Y. (CNRS, Strasbourg). Radiochem. Radioanal. Lett.; 9: No. 4, 237-45(4 Mar 1972).

Chemical after-effects were observed following the isomeric transition of ^{119m}Sn and the electron capture of ^{57}Co in the hydrated chlorides of Sn(II) and Co(II) but not in the phosphates. (auth)

22655 ADDITION OF ^{18}F ATOMS TO ACETYLENE. Williams, Ronald L.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Amer. Chem. Soc.; 94: No. 4, 1047-51 (23 Feb 1972).

Energetic ^{18}F atoms from the ^{19}F(n,2n)^{18}F nuclear reaction react with acetylene to form CH ≡ C^{18}F in 2 to 3% yield. Both energetic and thermal ^{18}F atoms form ·CH = CH^{18}F* by addition to acetylene, and this radical can be observed as CH_2 = CH^{18}F after collisional stabilization followed by reaction with scavenger HI. In excess SF_6, the pressure for half stabilization of ·CH = CH^{18}F* against ^{18}F loss is ≤200 torr (lifetime ≥5 × 10^{-10} sec). No evidence was found for pressure-dependent decomposition of ·CH = CH^{18}F* by H atom loss. The combination of acetylene plus HI serves as an effective scavenger for near-thermal ^{18}F atoms in various reaction systems. (auth)

22656 COMPETITIVE ADDITION OF NEAR-THERMAL ^{18}F ATOMS TO OLEFINS. Smail, Thomas; Iyer, R. Subramonia; Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Amer. Chem. Soc.; 94: No. 4, 1041-6(23 Feb 1972).

Near-thermal ^{18}F atoms, produced by the ^{19}F(n,2n)^{18}F nuclear reaction and moderated in kinetic energy by collisions with excess SF_6, were reacted with the fluorinated ethylenes. The radicals formed by ^{18}F addition are predominantly collisionally stabilized at 5 atm of pressure and are identified after abstraction of H from HI as the corresponding fluoroalkane-^{18}F. In intermolecular competition, the ^{18}F atoms react preferentially with less fluorinated positions. Intramolecularly, ^{18}F addition is also preferred at the less fluorinated end of the molecule. The competitive reaction ratios per molecule are generally independent of olefin/HI ratios, as well as of the ratios of two competing olefinic substrate molecules. The decomposition by CF_2 loss of CHF^{18}FCF$_2$· radicals from near-thermal addition of ^{18}F to CHF = CF_2 proceeds with a pressure for half stabilization of 45 ± 5 torr in CHF = CF_2. (auth)

Hot-Atom Chemistry

22657 DIFFERENCE BETWEEN THE APPEARANCE ENERGIES OF RECOIL SPECIES FROM INDIUM AND LUTETIUM EDTA COMPLEXES. Yoshihara, K.; Mizusawa, T. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 9: No. 4, 263-8 (4 Mar 1972).

Different appearance energies were found for recoil species of indium and lutetium EDTA complexes. The kinetic energy of the recoil atoms in these systems was varied by changing the energy of the incident γ rays in the ^{115}In(γ,γ')^{115m}In and ^{176}Lu(γ,γ')^{176m}Lu reactions. The observed appearance energy of Lu^{3+} in the lutetium complex is lower than that of In^{3+} in the indium complex. This is discussed in terms of differences in the coordination state and/or inclination to recombination reactions just after the recoil event. (auth)

22658 PREPARATION OF THORIUM PHTHALOCYANINE, AND STUDY OF ITS HOT ATOM CHEMISTRY BY SUBLIMATION METHOD. Endo, K.; Sakanoue, M. (Kanazawa Univ., Japan). Radiochem. Radioanal. Lett.; 9: No. 4, 255-61(4 Mar 1972).

A method is proposed for the preparation of thorium phthalocyanine. Sublimatography was successfully applied for the separation of the daughter nuclides or the recoil atoms produced by neutron irradiation. By combining the proposed method with 14-MeV neutron irradiation, thorium phthalocyanine enriched in ^{231}Th can be prepared. (auth)

22659 CHEMICAL REACTIONS OF ENERGETIC FLUORINE ATOMS WITH 1,1,1-TRIFLUOROETHANE. Krohn, Kenneth Albert. Davis, Calif.; Univ. of California (1971). 282p. University Microfilms Order No. 72-3587.

Thesis.

The reactions of recoil ^{18}F hot atoms with CH_3CF_3 were studied over the fugacity range 0.026 to 30 atm. Absolute yields were measured for the ^{18}F containing products. New hot abstraction reaction channels were demonstrated for nuclear recoil ^{18}F atoms reacting with fluorocarbon substrates. Hot F-to-HF abstraction in CH_3CF_3 is a very efficient process with an absolute hot yield of 51 ± 3%. The thermal abstraction yield is 17 ± 1%. Hot F-to-F_2 absolute yields in CH_3CF_3, C_2F_6, and C_3F_8 are 5.4 ± 0.3, 6.9 ± 0.8, and 11.7 ± 0.5%, respectively. In good agreement with theoretical expectations, translational excitation appears to be much more effective as a driving force for the exoergic F-to-HF process in comparison with the endoergic F-to-F_2 process. The Arrhenius activation energy for thermal F-to-HF abstraction in CH_3CF_3 is at least 2.1 ± 0.1 kcal/mole larger than the value associated with the thermal ^{18}F atom pi-addition process in C_3F_6. Nuclear recoil ^{18}F atoms undergo hot F-for-F and F-for-H substitution and hot F-for-CH_3 and F-for-CF_3 alkyl replacement reactions in CH_3CF_3. The primary absolute yields corresponding to these processes are 3.56 ± 0.07, 8.22 ± 0.09, 5.79 ± 0.31, and 8.5 ± 2.5% (estimated value), respectively. The total primary hot yield for organic products is 26.1 ± 2.5%, and that for all hot reactions including F-to-HF and F-to-F_2 abstraction is 83 ± 3%. There is no evidence in favor of hot F-for-2F or F-for-2H double substitution in CH_3CF_3. Recoil ^{18}F exhibits approximately a sixfold systematics preference for alkyl replacement reactions at the carbon–carbon bond in CH_3CF_3 relative to the average of substitution reactivities at carbon–fluorine and carbon–hydrogen bonds. The per-bond preference for primary substitution reactions at carbon–hydrogen relative to carbon–fluorine bonds is 2.30 ± 0.06. The sums of primary hot yields for organic products are comparable for recoil ^{18}F in CH_3CF_3 vs recoil ^{3}H in alkanes, so that these two systems differ principally in that ^{18}F exhibits a preference for alkyl replacement reactions, whereas recoil ^{3}H exhibits a preference for T-for-H substitution. All the organic products from primary ^{18}F hot reactions exhibit extensive unimolecular decomposition. Based upon thermochemical evidence alone, substantial fractions of the primary hot F-for-H, F-for-CH_3, and F-for-CF_3 reaction products are indicated to involve excitation energies in excess of 7.9 ± 0.2, 9.3 ± 0.1, and 3.5 ± 0.2 eV, respectively. The primary F-for-F reaction products in CH_3CF_3 do not decompose via a C–C bond scission mode in apparent violation of RRKM predictions. The primary F-for-H products decompose both via HF elimination and C–C scission in apparent accord with theory. More than one kind of microscopic dynamics is involved in the primary hot F-for-H and F-for-CH_3 processes in CH_3CF_3. Direct, concerted, and collusive dynamics are required for the higher energy reaction modes for these processes .Diss. Abstr. Int., B)

22660 AB INITIO STUDIES OF HYDROGEN EXCHANGE AND ABSTRACTION IN THE H + CH_4 SYSTEM. Ehrenson, S.; Newton, M. D. (Brookhaven National Lab., Upton, N. Y.). Chem. Phys. Lett.; 13: No. 1, 24-9(1 Feb 1972).

Energies and optimal geometries were computed in the UHF LCAO MO GTO framework for reactant, product, and likely intermediate structures in the exchange and abstraction reactions of H + CH_4. The effects of addition of polarization functions to both the hydrogen and carbon basis sets were evaluated. (auth)

Properties of Radioactive Materials

Refer also to abstract 24796.

22661 KINETICS OF REDUCTION OF HEXAVALENT URANIUM IN SULPHURIC ACID SOLUTIONS. A SIMPLIFIED METHOD FOR DETERMINING THE PARAMETERS OF IRREVERSIBLE WAVES. Issa, I. M.; Tharwat, M. (Assiut Univ., Egypt). Electrochim. Acta; 17: No. 2, 343-9(Feb 1972).

The polarographic behavior of U(VI) was studied in sulphuric acid solutions of different concentrations and the different kinetic parameters determined. The nature of the polarograms differs in accordance with the acid concentration. The diffusion coefficient of U(VI) was found to be 3.51 × 10^{-6}, 6.02 × 10^{-6} and 6.52 × 10^{-6} cm^2/s for 5.0, 1.0 and 0.1 M H_2SO_4 respectively. The waves being irreversible were analyzed by the Koutecky–Delahay treatments and also by a proposed simpler procedure; the latter proved to be easiest and more rapid. The values of the different kinetic parameters reveal that the irreversibility of the electrode reaction decreases with rise of sulphuric acid concentration. (auth)

22662 ADSORPTIVE PROPERTIES OF CHEMICALLY HETERODYNAMIC OXYGEN ATOMS (IONS) IN V, U, AND Mn OXIDES. Mardaleishvili, R. E.; Daneliya, A. P. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 200: No. 1, 145-8(1 Sep 1971). (In Russian).

The adsorptive properties of oxygen centers on the surfaces of

oxides of V, U, and Mn were investigated at −196, −210, and −220°C. Adsorption isotherms were determined for H_2 and N_2 gases on the three oxide surfaces. Hydrogen adsorbed only on the Me-centers of absorption on the three surfaces; H_2 adsorbed both on Me- and on O-centers. (K.S.W.)

22663 REDUCTION TO Cf^{4+}, Es^{3+}, AND Fm^{3+} IN MIXED SOLVENT OF WATER–ETHANOL. Mikheev, N. V.; Kamenskaya, A. N.; Rumer, I. A.; (and others) (Inst. of Chemical Physics, Moscow). Radiochem. Radioanal. Lett.; 9: No. 4, 247-54(4 Mar 1972). (In French).

The reduction of Cf, Es, and Fm to the divalent state in aqueous ethanol solutions is reported. The identification of the Me^{2+} state is based on the true isomorphous cocrystallization of these elements with $SmCl_2$. The values of the standard oxidation–reduction potential of $Me^{2+} \rightleftharpoons Me^{3+} + e$ for Cf, Es, and Fm are estimated. (auth)

22664 SOLUBLE INTERMEDIATES IN THE HYDROLYSIS OF NEPTUNIUM(VI) AND COMPARISON WITH OTHER ACTINIDES(VI). Cassol, A.; Magon, L.; Tomat, G.; Portanova, R. (Consiglio Nazionale delle Ricerche, Padua. Univ., Catania, Italy). Inorg. Chem.; 11: No. 3, 515-19(Mar 1972).

The soluble hydroxo complexes of the neptunyl(VI) ion were studied in aqueous solution with 1 M $(Na)ClO_4$ at 25°C by emf measurements of $[H^+]$. Trial values of the equilibrium constants were estimated by graphical procedures and refined by a least-squares program. The main species produced and their refined hydrolysis constants are as follows: NpO_2OH^+, $\log {}^*\beta_{11} = -5.17 \pm 0.03$; $(NpO_2)_2(OH)_2^{2+}$, $\log {}^*\beta_{22} = -6.68 \pm 0.02$; $(NpO_2)_3(OH)_5^+$, $\log {}^*\beta_{53} = -18.25 \pm 0.02$. Comparison of these results with some available data on the hydrolysis of uranyl(VI) and plutonyl(VI) indicates a close analogy in hydrolysis schemes for the three ions. The trend in acidity with increasing atomic number is briefly discussed. (auth)

22665 CRYOMETRIC STUDIES OF THE SYSTEM $AgCl–UCl_4$. Terpilowski, J.; Gawel, W.; Bogacz, A. (Inst. of Chemistry and Tech. of Medical Products, Wroclaw). Rocz. Chem.; 46: No. 1, 3-8(1972). (In Polish).

The phase diagram of the system $AgCl–UCl_4$ was constructed. The compound Ag_2UCl_6, congruently melting at 407.4°C, as well as two eutectics of composition 22.1 and 42.3 mole % UCl_4 and a melting temperature 363.2 and 389.0°C, respectively, were found. The polymorphic transition $\alpha\text{-}UCl_4 \rightleftharpoons \beta\text{-}UCl_4$ temperature was determined to be equal to 554.7°C. Based on the liquidus curve, values of the heat of fusion (4.65 ± 0.40 kcal/mole of AgCl and 8.45 ± 0.52 kcal/mole of Ag_2UCl_6 established by the cryometric method), and literature data, the thermodynamic characteristic of a liquid phase in the system $AgCl–UCl_4$ was given. The activities of AgCl (α_1), UCl_4 (α_2), and the partial molar free energy of components ($\bar{G}_1^E$, $\bar{G}_2^E$) were calculated. Considerable negative deviations of liquid solutions $AgCl–UCl_4$ from Raoult's law were found. The existence of the complex ions UCl_6^- in investigated liquid solutions was concluded. (auth)

22666 REVERSIBLE DISMUTATION OF URANYL(V) IN THE MOLTEN LITHIUM CHLORIDE–POTASSIUM CHLORIDE EUTECTICS. Landresse, G.; Duyckaerts, G. (Laboratoire de Chimie Analytique et Nucleaire, Liege). Anal. Chim. Acta; 58: No. 2, 369-78(Feb 1972). (In French).

Visible and near-infrared absorption spectrophotometry provides a satisfactory method for quantitative analysis of molten salt solutions. This technique made it possible to study the disproportionation of uranyl(V). The reaction $2\ UO_2^+ + 4\ HCl \rightleftharpoons UO_2^{2+} + U^{4+} + 2\ H_2O + 4\ Cl^-$ is in accord with the observations made in fused LiCl–KCl eutectic at 450°C for pressures of hydrogen chloride ranging from 60 to 230 mm Hg. (auth)

22667 HYDROGEN ION (PROTON) CONDUCTION IN THORIA-BASE SOLID ELECTROLYTES. Shores, David A.; Rapp, Robert A (Ohio State Univ., Columbus). J. Electrochem. Soc.; 119: No. 3, 300-5(Mar 1972).

The total conductivities of a series of ThO_2-base electrolytes were determined over a wide range of oxygen activity in atmospheres of $H_2–H_2O–Ar$ mixtures. At 1200 and 1400°C and low oxygen activities, a significant conductivity contribution corresponding to hydrogen ion (proton) conduction was found for electrolytes with high dopant contents. The experiments are interpreted in terms of a defect model involving two dopants. (auth)

22668 ^{99m}Tc-PENICILLAMINE–ACETAZOLAMIDE COMPLEX, A NEW RENAL SCANNING AGENT. Halpern, S.; Tubis, M.; Endow, J.; (and others) (Wadsworth Veterans Hospital, Los Angeles. Univ. of California, San Diego). J. Nucl. Med.; 13: No. 1, 45-50(Jan 1972).

Technetium-99m-penicillamine-acetazolamide complex (TPAC); a new renal scanning agent, is prepared by the reduction of pertechnetate by penicillamine followed by complexing of this compound with acetazolamide. Plasma half-time disappearance of the compound ranges from 45 to 60 min in a dog with normal kidneys. If the kidneys are excluded from the circulation, half-time disappearance is prolonged to 90 min. TPAC is 97% protein bound to all classes of plasma proteins, the majority, however, being associated with the albumin fraction. Minute amounts are removed from the circulation by the kidney by either glomerular filtration and tubular reabsorption or by tubular extraction and delayed excretion. Outstanding scan images can be obtained in patients with very severe renal disease. (auth)

22669 "KIT" METHOD FOR THE PREPARATION OF A TECHNETIUM–TIN(II) COLLOID AND A STUDY OF ITS PROPERTIES. Lin, Max S.; Winchell, H. Saul (Univ. of California, Berkeley). J. Nucl. Med.; 13: No. 1, 58-65(Jan 1972).

A "kit" method for the preparation of a technetium–tin(II) colloid is presented. The entire procedure for preparing the colloid consists of adding technetium generator eluate and albumin solution in that order to an aqueous tin(II) in a vial. Properties of the colloid are discussed. (auth)

22670 INVESTIGATION OF METAL CUPFERRONATES BY INFRARED SPECTROSCOPY. Pilipenko, A. T.; Shevchenko, L. L.; Strokan, V. N (Kiev State Univ.). Zh. Neorg. Khim.; 16: No. 9 2399-2403(Sep 1971). (In Russian).

The ir spectra of cupferronates of Cu, Hg^{2+}, Al, Fe, Ga, Bi^{3+}, Ti, V, Zr, Th, U^{4+}, and Nb^{5+} were investigated in vaseline oil in the region 3,800 to 30 cm^{-1}. It was noted that certain bands characteristic of the parent nitrosophenylhydroxlamine disappeared because of complex formation. The similarity of ir spectra of the series of metals of the same valence state suggests a like structure of their compounds with a chelate ring through two oxygen atoms. The frequencies of bands near 930 and 400 cm^{-1} regularly decrease with increasing atomic mass of the metal. (K.S.W.)

22671 CRYSTALLINE STRUCTURE OF CESIUM TETRABROMOURANYLATE $Cs_2[UO_2Br_4]$. Mikhailov, Yu. N.; Kuznetsov, V. G. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 9, 2512-16(Sep 1971). (In Russian).

X-ray patterns of a spherical monocrystal of $Cs_2[UO_2Br_4]$ yielded crystalline structure with a monoclinic unit cell having the parameters a = 9.959, b = 9.806, and c = 6.415 Å, $\beta = 104°50'$, and an experimentally determined density of 4.64 g · cm^3. A flattened tetragonal bipyramid contains four Br atoms in its equatorial plane and at the corners of a square. The length of the U–Br bond is 2.82 Å, the U–O bond is 1.70 Å. The coordination number of Cs is 11. (K.S.W.)

22672 KINETIC STUDIES OF THE ELECTRODE AND DISSOCIATION REACTIONS OF URANYL–DTPA COMPLEXES BY POLAROGRAPHIC METHOD. Lai, Tsai-teh; Wen, Chaur-shyong (Cheng Kung Univ., Tainan, Taiwan). J. Inorg. Nucl. Chem.; 34: No. 2, 709-17(Feb 1972).

The uranium-DTPA (diethylenetriammine pentacetic acid) chelate gives a two-step irreversible reduction wave when the concentration of the surface-active substance, Triton X-100, is greater than 0.003%, due to the adsorption of surface-active substance on the mercury electrode. The limiting current of the first wave is controlled partially by the rate of electrode reaction. The electrode reaction of the second wave is a rate-determining step corresponding to the dissociation of the uranyl-DTPA chelate. The rate constants of the electrode and dissociation reactions were determined. The limiting current and the rate constants are a function of the concentration of Triton X-100. The dissociation rate constants are pH dependent and correlated by the equation $k_1^- = -3.47 \log [H^+] - 13.2$. (auth)

22673 CHELATE FORMATION BETWEEN QUINQUEVALENT NEPTUNUM AND 1,3-DIKETONES. Gross, J.; Keller, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.; 34: No. 2, 725-38(Feb 1972). (In German).

Spectrophotometric titration of pentavalent neptunium with various 1.3-diketones, $RCOCH_2COR'$, in aqueous solution showed formation of 1 : 1 and 1 : 2 chelates, except with trifluoroacetylacetone and hexafluoroacetylacetone; both of the latter formed only 1 : 1 chelates. The stability constants of the chelates were calculated using a IBM 360 computer. As expected, the log β-values of the NpO_2^+-chelates were about half those of the UO_2^{2+}-chelates for the same chelating agent. There was a clear dependence of the stability constant on the pK-value of the chelating agent within the same series. The formation of the chelates in the system NpO_2^+/acetyl acetone was investigated as a function of temperature. The thermodynamic values ΔG, ΔH, and ΔS of the reaction were calculated from the data. (auth)

22674 ABSORPTION SPECTRA OF Bk(III) AND Bk(IV) IN SEVERAL MEDIA. Baybarz, R. D. (Oak Ridge National Lab., Tenn.); Stokely, J. R.; Peterson, J. R. J. Inorg. Nucl. Chem.; 34: No. 2, 739-46(Feb 1972).

The absorption spectrum of Bk(III) in 1M $DClO_4$–99.9% D_2O was studied over the spectral region 200 to 1700 nm. Thirteen new absorption bands below 320 nm, including the previously unreported f → d transition bands at 242 and 212 nm, were observed. The absorption spectra of electrolytically produced Bk(IV) in 1M $HClO_4$, 1M H_2SO_4, 2M K_2CO_3, 7.5 M H_3PO_4, and 0.5M bis(2-ethyl hexyl)ortho phosphate (HDEHP) in dodecane were also investigated. The Bk(IV) spectrum was found to be characterized by a very strong electron transfer band at ~280 nm and only weak bands corresponding to "forbidden" f → f transitions, in the visible wavelength region. Molar absorptivities were determined for the various bands in both Bk(III) and Bk(IV) spectra. (auth)

22675 HYDROUS THORIUM OXIDE: A STUDY OF ITS AMPHOTERIC BEHAVIOUR. Subuktagin, S. W. M.; Prasad, R. (Patna Univ., India). J. Inorg. Nucl. Chem.; 34: No. 3, 1053-8(Mar 1972).

The adsorption of anions and cations on hydrous thorium oxide was studied. The method of least squares was used to determine the adsorption isotherms. Hydroxide prepared with deficient alkali adsorbs more anions, whereas samples prepared with excess of alkali adsorb more cations. The results established the amphoteric character of hydrous thorium oxide. Heats of adsorption were calculated. (auth)

22676 KINETICS AND MECHANISM OF THE FORMATION OF THE BROWN COMPLEX OF PLUTONIUM(IV) AND HYDROGEN PEROXIDE. Ekstrom, A.; McLaren, A. (Australian Atomic Energy Commission, Lucas Heights). J. Inorg. Nucl. Chem.; 34: No. 3, 1009-16(Mar 1972).

The rate of formation of the complex is given by the expression: $d[complex]/dt = [H_2O_2][Pu(IV)]^2\{k_2[H^+]^{-1} + k_3[H^+]^{-2}\}$. The values of k_2 and k_3 and their activation energies were determined. Reaction mechanisms consistent with the observed rate law are discussed. (auth)

22677 SYSTEM $UO_2(NO_3)_2$–UO_3–H_2O. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem.; 34: No. 2, 531-4(Feb 1972).

The phase diagram of the system $UO_2(NO_3)_2$–UO_3–H_2O at 25°C was determined. Only three solid phases were found in this system: $UO_2(NO_3)_2 \cdot 6H_2O$, $UO_3 \cdot 2H_2O$ and a metastable basic uranyl nitrate. The phase $UO_3 \cdot 2H_2O$ exhibits a pronounced solubility in this system. (auth)

22678 CHEMECA '70. Conference Held at Melbourne and Sidney, 19–26 August 1970. Sydney; Butterworths (1971). 1121p. (CONF-700854).

Eighty five papers dealing with various aspects of chemical engineering were presented. Sessions were held in particle mechanics, high-temperature processes, chemical reaction engineering, biochemical and biomedical engineering, diffusional processes, process dynamics-simulation and control, and scientific management in the process industries. A separate abstract was prepared for one paper. (Australia)

For abstract of an individual paper see: 22679.

22679 INTRAPELLET TRANSPORT IN GAS-SOLID NON-CATALYTIC REACTIONS. Calvelo, A.; Smith, J. M. (Univ. of California, Davis). pp 3.1-24 of CHEMECA '70. Sydney; Butterworths (1971).

From CHEMECA '70 conference; Melbourne and Sydney, Australia (19 Aug 1970). See CONF-700854.

Gas-solid, non-catalytic reactions were analyzed under conditions such that reaction occurs over a region of the pellet rather than topographically. A new model known as the particle-pellet model is proposed in which the pellet is formed by compressing non-porous, reactant particles. In such a system both intrapellet diffusion and reaction resistances can be significant so that the shrinking-core model is not realistic. Methods are presented for predicting temperatures and conversions of single pellets as a function of time using the proposed model. For non-isothermal, exothermic reactions, multiple, stable solutions exist, and transition from a high-temperature solution to a low-temperature one can occur during the reaction process. Experimental data for the $UO_2(s) + HF(g)$ reaction were analyzed with the particle-pellet model. Correlation of conversion-time data, and evaluation of rate constants and activation energies by both shrinking-core and particle pellet models, are discussed. (auth)

22680 THERMODYNAMIC FUNCTIONS OF COMPLEX FORMATION AND IONIC RADII. I. DETERMINATION OF FREE ENTHALPY: THE ENTROPY AND ENTHALPY OF LANTHANIDE AND ACTINIDE ACETATO COMPLEXES FROM INTERATOMIC DONOR-ACCEPTOR DISTANCES. Muenze, Rudolf (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). J. Inorg. Nucl. Chem.; 34: No. 2, 661-8(Feb 1972). (In German).

The thermodynamic functions of the formation reaction $Me^{3+}_{aq} + CH_3COO^-_{aq} \rightleftharpoons (MOOCCH_3)^{2+}_{aq}$ were calculated for trivalent actinides and lanthanides using electrostatic assumptions for the ligand-central atom interaction, and compared with experimental results. (auth)

22681 THERMAL DECOMPOSITION OF SODIUM, TITANYL, AND URANYL PEROXIDE BY THE DOUBLE-TAGGED ISOTOPE TRACER TECHNIQUE. Seyse, Robert J.; Gordon, Gilbert (Univ. of Iowa, Iowa City). J. Inorg. Nucl. Chem.; 34: No. 2, 477-86(Feb 1972).

The double-tagged isotope tracer technique is discussed in reference to the decomposition of metal peroxides. The results show that sodium peroxide octahydrate initially decomposes with almost no scrambling of oxygen isotopes between peroxide ions. However, as decomposition proceeds, the amount of scrambling increases. The increase appears to be temperature dependent. Uranyl peroxide dihydrate and titanyl peroxide hydrate were also studied with this technique and found to give 20 percent and 30 percent initial scrambling, respectively. The amount of scrambling also increases as decomposition proceeds, but is not temperature dependent. Possible mechanisms for these decomposition processes are discussed. (auth)

22682 ENERGY MIGRATION IN FROZEN SOLUTIONS OF URANYL COMPOUNDS. Turetskaya, E. A. Zh. Prikl. Spektrosk.; 15: No. 3. 547-9(Sep 1971). (In Russian).

The intermolecular energy transfer in frozen solutions of uranyl nitrate and uranyl perchlorate was studied. The characteristic separation distance for transfer, estimated from the relative luminescence output by the energy donor (uranyl nitrate) relative to the concentration of the acceptor (uranyl perchlorate), was equal to 16 Å. The formula for the inductive resonance energy between two electric dipoles gave the significantly lesser value of 5 Å for the given system. (tr-auth)

22683 HYDRATES OF AMMONIUM PENTAFLUOROURANYLATE. Seleznev, V. P.; Tsvetkov, A. A.; Sudarikov, B. N.; Gromov, B. V. (Moscow Chemical Tech. Inst.). Zh. Neorg. Khim.; 16: No. 8, 2201-5(Aug 1971). (In Russian).

A study of the structure of $NH_4[(UO_2)_2F_5] \cdot 4H_2O$ indicated it crystallized in the hexagonal system with lattice parameters a = 16.84 Å, c = 7.07 Å, density = 4.13 g/cm³ (exptl) and 4.21 g/cm³ (x-ray). The corresponding trihydrate was rhombic with parameters a = 14.96 Å, b = 17.96 Å, c = 15.70 Å, z = 16, density = 4.28 g/cm³ (exptl) and 4.45 g/cm³ (x-ray). The ir spectra of these salts revealed a splitting of $\nu_3(UO_2^{2+})$ into two constituents, suggesting the nonequivalence of the uranyl groups. (tr-auth)

22684 TENSIMETRIC STUDY OF HYDRATES OF AMMONIUM PENTAFLUORODIURANYLATE. Tsvetkov, A. A.; Seleznev, V. P.; Sudarikov, B. N.; Gromov, B. V. (Moscow Chemical Tech. Inst.). Zh. Neorg. Khim.; 16: No. 8, 2306-8(Aug 1971). (In Russian).

The decomposition of $NH_4[(UO_2)_2F_5] \cdot 4H_2O$ was studied in a tensimeter, obtaining isotherms at 40 and 60°C in a vapor pressure–composition diagram for this salt. In a second experiment with the $NH_4[(UO_2)_2F_5]$–H_2O system, measurements were taken over the range 30 to 120°C for establishing a log p vs-1/T plot. Heats of hydration were calculated for the stepwise dehydration equilibria, which ranged from 8.81 to 12.27 kcal/mole H_2O. (K.S.W.)

22685 INFRARED SPECTRA OF SOME METAL COMPLEXES WITH ARSENAZO I AND THORON I. Pilipenko, A. T.; Shevchenko, L. L. Zh. Neorg. Khim.; 16: No. 8, 2124-8(Aug 1971). (In Russian).

A comparison of the ir spectra of Arsenazo I and its Th, Pb, Bi, and Tl complexes, and also Thoron I and its complexes with Th and Bi in the 3,800 to 4,000 cm^{-1} region showed that these metals reacted with the arsono group. Both Arsenazo I and Thoron I exist in the hydrazoquinone form. A shift toward longer wave lengths of the bands associated with vibrations of the C = C–HN–N– group was observed to decrease in the order Th > Tl > Bi > Pb and to indicate an interaction of the metal with it. (K.S.W.)

Radioactive Waste Treatment

22686 PRESENT STATE AND FUTURE OF INCORPORATION OF RADIOACTIVE WASTES INTO BITUMEN IN HUNGARY. Magyar, M. (Magyar Asvanyolaj- es Foeldgazkiserleti Intezet, Veszprem, Hungary); Mozes, Gy.; Feher, L. Izotoptechnika; 14: No. 11, 519-28(Nov 1971). (In Hungarian).

A continuous pilot plant for handling high-salinity radioactive wastes and experiments on handling low-salinity ones are described. (auth)

22687 USE OF ELECTROSTATIC FILTER ASH FOR DECONTAMINATION OF SEWAGE CONTAINING RADIONUCLIDES. Otto, R.; Hecht, P. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Leipzig). Isotopenpraxis; 7: No. 10, 412-16(Oct 1971). (In German).

Studies are reported regarding the use of electrostatic filter ash for decontaminating laboratory sewage containing some of the most commonly used radionuclides. Model water systems were stirred with the electrostatic filter ash under different conditions. An efficiency up to 99% can be obtained, depending on the present radionuclides and on the admixture of small amounts of an auxiliary chemical as NaOH, $NaHCO_3$ or Na_2CO_3. The influence of foreign matter in the water (organic solvents, surface active or complexing agents) on the efficiency was also investigated. (auth)

Radioisotope Production

Refer also to abstract 25034.

22688 PRODUCTION OF ^{99m}Tc. (to Union Carbide Corp.). British Patent 1,265,769. 8 Mar 1972. Priority date 20 Jun 1969, United States.

A process for the production of technetium-99m of high purity and concentration is described. An aqueous solution of 99.99% pure fission product ^{99}Mo is contacted with a column containing an organic substrate, such as alumina or zirconium oxide. The system is eluted with a solvent to separate ^{99m}Tc from ^{99}Mo deposited on the substrate. It was found that ^{99m}Tc can be separated from the ^{99}Mo compound with over 80% efficiency. (J.G.B.)

22689 USE OF CYCLOTRONS IN MEDICINE. Kertesz, L. (Debreceni Orvostudomanyi Egyetem, Hungary); Dezsi, Z. Izotoptechnika; 14: No. 12, 567-75(Dec 1971). (In Hungarian).

The medical requirements for and the most significant results of the use of cyclotrons are described. Isotope production, activation analysis, and particle irradiation in the medical practice are discussed. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 22759, 23165, 23271, and 24726.

22690 (AECL-3911, pp 47-54) CHEMICAL ENGINEERING RESEARCH AND DEVELOPMENT FOR FUEL REPROCESSING AND HEAVY-WATER PRODUCTION. Rae, H. K. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

Heavy water production is becoming an important part of the Canadian chemical industry. Present plants are based on an established foreign technology, and AECL has participated in the task of learning and applying it in Canada. Computer simulations of each plant were developed and studies of the process chemistry were begun. A heavy water process based on hydrogen-amine exchange is described. Laboratory and pilot-scale studies confirm earlier assessments of its advantages. Homogeneously catalyzed by potassium methylamide, this deuterium exchange reaction has posed unusual analytical, kinetic, and mass transfer problems. Reprocessing irradiated fuel to recover plutonium could become a large industry in Canada by 1990. The use of natural uranium in CANDU reactors offers a unique opportunity to apply a compact and simple process in which only plutonium is extracted, without having to separate the spent uranium from its fission products. Studies at WNRE demonstrate that this can be done by extraction with a tertiary amine. Design and cost studies forecast cheaper plutonium from Canadian fuel by this route than from the tributyl phosphate extraction process now used in several countries to separate both uranium and plutonium from fission products. (auth) (Canada)

22691 (DOCKET-50268-24) MIDWEST FUEL RECOVERY PLANT. Extension of Construction Completion Date and Withdrawal of Request for Withholding Information. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 2 Mar 1972. 4p. Dep. NTIS.

Extension of the construction completion date from April 1, 1972 to April 1, 1973 is requested for completion of reviews required for issuance of the operating license. The request for withholding information from amendment 17 was withdrawn. (M.C.G.)

22692 (KFK-1367) MACHINE EVALUATION OF IN-LINE MEASURED VALUES IN REPROCESSING OF IRRADIATED FUEL ELEMENTS. Baumgaertel, G.; Mache, H.-R.; Rietzschel, K. (Kernforschungszentrum, Karlsruhe (West Germany)). Apr 1971. 19p. (In German). Dep. NTIS (U. S. Sales Only).

The Institute for Hot Chemistry at Karlsruhe possesses a research installation that yields experience about process control during reprocessing of irradiated fuel elements. Through a 1-km data channel, the instruments of the installation are connected with a process computer. With two in-line instruments, operation of the system is explained. In-line polarography as well as the measurement of density and conductivity are described. (H.B.G.)

22693 (ORNL-4728, pp 178-228) MOLTEN-SALT PROCESSING AND PREPARATION. (Oak Ridge National Lab., Tenn.). Feb 1972.

In Molten-Salt Reactor Program.

BERYLLIUM — separation from spent MSBR fuel
BERYLLIUM FLUORIDES — BeF_2-LiF-ThF_4, separation of protactinium and uranium from molten, by oxide precipitation
BISMUTH — solvent properties for rare earths and thorium
— distribution between molten lithium chloride and liquid lithium-thorium-bismuth alloy
FISSION PRODUCTS — separation from spent MSBR fuel
FUSED SALTS — purification of, method for continuous
LITHIUM — separation from spent MSBR fuel
— distribution between molten lithium chloride and liquid lithium-thorium-bismuth alloy
LITHIUM FLUORIDES — BeF_2-LiF-ThF_4, separation of protactinium and uranium from molten, by oxide precipitation
MOLTEN SALT BREEDER REACTOR — materials requirement estimates for 1968-2000
— fuel reprocessing for
PROTACTINIUM — separation from MSBR fuel salt by oxide precipitation
RADIOACTIVE WASTE — disposal from MSBR fuel reprocessing, long-term
RADIOCHEMICAL PROCESSING PLANTS — economic aspects of, for MSBR fuel reprocessing
— off-gas treatment from MSBR fuel reprocessing in
RARE EARTHS — solubility in liquid bismuth
REACTOR FUELS — reprocessing of molten salt, engineering developments for
— reprocessing of molten salt, cost estimates of plant for
— reprocessing of molten salt, by fluorination, reductive extraction, and metal transfer
THORIUM — separation from spent MSBR fuel
— solubility in liquid bismuth
THORIUM FLUORIDES ThF_4 — BeF_2-LiF-ThF_4, separation of protactinium and uranium from molten, by oxide precipitation
URANIUM — separation from MSBR fuel salt by oxide precipitation
— separation from spent MSBR fuel
— separation from molten fluorides, fluorination efficiency for (M.C.G.)

22694 SPENT-FUEL REPROCESSING. Osborn, Kenneth R. (Allied Chemical Nuclear Products, Inc., Morristown, N. J.); Larson, Howard J. Proc. Amer. Power Conf.; 33: 247-52(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The Barnwell Fuel Processing Plant is described and some important problems facing this segment of the nuclear fuel cycle industry are discussed. The Barnwell plant is designed for light-water reactor fuels utilizing both present-day uranium oxide fuels and future mixed oxide plutonium recycle fuel. The process employed is the Purex process, modified to improve reliability and economic performance for the specific duty requirements. (M.C.G.)

22695 AUTOMATIC MEASUREMENT AND CONTROL OF NUCLEAR FUEL REPROCESSING BY SPECTROPHOTOMETRY AND CONDUCTIVITY MEASUREMENTS. Schmieder, Helmut; Kuhn, Erwin (Institut fuer Heisse Chemie, Karlsruhe, Ger.). Chem.-Ing.-Tech.; 44: No. 3, 104-11(Feb 1972). (In German).

The absorption spectra of Pu(III), Pu(IV), Pu(VI), U(IV), and U(VI) were recorded in nitric acid solution (0.3 to 8 M HNO_3). Key bands were selected for the various oxidation states and empirical functions determined for the dependence of the molar extinction coefficients on the HNO_3 concentration in order to facilitate multicomponent analysis. With the aid of the electric conductivity of the solutions it is possible to determine not only the concentrations of the individual oxidation states but also to gain an approximate value for the HNO_3 concentration. The use of this method for the automatic control of nuclear fuel reprocessing (Purex process) is discussed. In addition to the constructional details of a process photometer for multicomponent analysis the possibility of computerized process control for the particular example of electrolytic separation of Pu and U is considered. (auth)

22696 PREPARATION AND ION-EXCHANGE PROPERTIES OF TITANIUM PHOSPHATE-SILICATE (TPS), AND ITS USE IN SEPARATIONS OF RADIONUCLIDES. Naqvi, S. J.; Huys, D.; Baetsle, L. H. (SCK/CEN, Mol, Belg.). J. Inorg. Nucl. Chem.; 33: No. 12, 4317-26(Dec 1971).

A method for the preparation of TPS was developed and study of its composition, pH-titration behavior, resistance to acid attack and ion exchange selectivity was undertaken. The results of this study are reported. Zr–Nb was more strongly adsorbed on TPS than any other cation studied and the fixation mechanism is very likely an absorption in the exchanger matrix. Cs and Pu were fairly well adsorbed by TPS and the adsorption increased with the PO_4: Ti ratios when present in trace quantities but as soon as the carrier concentration increased the distribution coefficient dropped sharply. The relative position of the sorption curves for UO_2^{2+}, Ce^{3+} and Ru is the same as for TiP and ZrP. The introduction of silica into the TPS matrix depressed the typical ion exchange properties but improved the absorptive properties for tetravalent ions. Tests proved that TPS may be used in the process chemistry of irradiated uranium and plutonium to absorb quantitatively ^{95}Zr–^{95}Nb from a HNO_3 feed solution. (auth)

ENGINEERING

Energy Conversion

22697 (BMBW-FBK-71-23) ISOTOPE BATTERY FOR CARDIAC PACEMAKER ISOCARD. Renner, T. (Siemens A. G., Erlangen (West Germany)). Dec 1971. 66p. (In German). Dep. NTIS (U. S. Sales Only).

A miniaturized, thermoelectric converter system is described which is intended for use in conjunction with a ^{238}Pu heat source as the power supply for pacemakers. It consists of a continuous meandering line of thermocouples vapor deposited onto a polyimide tape. The system directly supplies the necessary output voltage of 6 V. The most important stages in the production process, such as cutting and preparing the polyimide tape, the vapour depositing process, and wrapping the tape, are described in detail. Readings taken during continuous tests on electrically-heated models show that very good, reliable converter systems can be built using this method. Test results and estimates of the efficiency indicate that it is already possible to produce converter systems which can compete with the best systems known at the present time. In many aspects, the design and fabrication process have, however, not yet been perfected, so that in conjunction with a suitable ^{238}Pu capsule which is still to be built, a thermoelectric converter system can be expected which will very likely supersede the systems in use at present. (auth)

22698 (IPP-IV-19) PERFORMANCE OF MHD GENERATOR WITH RESPECT TO IONIZATION INSTABILITY AND OTHER DETRIMENTAL MECHANISMS. Zinko, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). May 1971. 40p. (In German). Dep. NTIS (U. S. Sales Only).

Alkali metal–rare gas MHD generators are intended primarily for application in a closed cycle consisting of a high-temperature reactor, MHD generator, steam or gas turbine, heat exchanger, and compressor. In order to determine whether these generators can be used at all, their electrical parameters, e.g., the power density as a function of the stagnation conditions in the reactor must be known. The ionization instabilities occurring in alkali metal–rare gas MHD generators exert a strong influence on the efficiency of the generator. Furthermore, the effect of loss mechanisms such as electrode drops and finite segmentation width is particularly pronounced in plasmas with elevated electron temperature. The behavior of alkali metal–rare gas plasmas was investigated with allowance for the stated loss mechanisms. The following gas mixtures were considered: Ar–K, Ar–Cs, Ne–Cs, and He–Cs. The electric power density and the specific power per meter are represented as functions of the alkali concentration, pressure and temperature in the reactor, Mach number, and polytropic efficiency. From these calculations it is possible to derive upper limits for the reactor pressure. This critical pressure region is checked by calculating MHD ducts of constant Mach number and comparing the thermal efficiencies that can be achieved with them in various types of power plants. (auth)

22699 (JPRS-55126) THERMODYNAMIC EFFICIENCY OF URANIUM-HEXAFLUORIDE MHD PLANTS. Gutman, I. I.; Dmitrievskii, V. A.; Tetel'baum, S. D. Translated from Teplofiz. Vys. Temp.; 9: No. 6, 1329-31(Nov-Dec 1971). 6p. NTIS.

The results of the calculation of the efficiency of MHD plants using UF_6 indicate that the system shows promise, and that further investigations on this system should be performed. (T.F.D.)

22700 (ORNL-NSF-EP-11) UNDERGROUND AIR STORAGE AND ELECTRICAL ENERGY PRODUCTION. Korsmeyer, R. B. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 17p. Dep. NTIS.

With the trend toward very large power plants, the problem of meeting peak power demands becomes acute, and large utilities have been turning to energy storage as a means of leveling out demand into a nearly steady base load. The only way that energy of such magnitude can be stored is either by pumping water to a higher elevation to take advantage of gravity or by compressing air in large underground caverns. Pumped-water storage is the more flexible method and can be fitted into various demand patterns with both hydro- and thermal-electric generating systems, but it generally must be situated in at least hilly terrain to obtain adequate differences in elevation and it uses considerable land surface. Underground air storage, on the other hand, can be located almost anywhere that firm rock can be found at depth, uses only about one-tenth of the land surface that equivalent pumped-water storage does, and uses the stored energy more effectively; but it can be utilized only in combination with gas turbine generators. At present air energy storage requires equipment development and, therefore, there are uncertainties in equipment cost estimates. There are also large uncertainties in excavation cost estimates and in possible environmental effects. The potential advantages of pumped-air storage are examined and recommendations are developed for research required to clarify the options. (auth)

22701 THEORETICAL STUDY OF DUCT MODELS FOR MHD GENERATOR OF 1 MW THERMAL POWER WITH COMBUSTION GASES. Brindus, L.; Lupas, N.; Gallin, E. (Inst. of Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 8, 917-39 (1971). (In Rumanian).

Information is presented on basic flow equations in the duct of the MHD generator, the flow in the constant area MHD duct, the flow in the constant velocity MHD duct, the flow in the constant Mach number MHD duct, and segmentation of electrodes. Conclusions and references are included. (auth)

22702 EFFECTS OF EXTERNAL CIRCUIT ON MHD SQUEEZE FILM BETWEEN CONDUCTING PLATES. Soundalgekar, V. M.; Amrute, A. S. (Indian Inst. of Tech., Bombay). Wear; 19: No. 2, 117-22(1972).

An analytical investigation is made of magnetohydrodynamic squeeze film between two electrically conducting plates and in the presence of the magnetic field in the free space. An expression for the time of approach, $\bar{t}$, has been derived for large M, the Hartmann number and examples are shown graphically. It is observed that an increase in the magnetic field in the free space leads to a decrease in $\bar{t}$. Also $\bar{t}$ is less in the presence of an external magnetic field than it is in the absence of an external magnetic field. (auth)

22703 MAGNETOHYDRODYNAMIC METHOD AND SYSTEM. Petrick, Michael (to United States Atomic Energy Commission). U. S. Patent 3,636,389. 18 Jan 1972. Filed 22 Mar 1971.

A magnetohydrodynamic (MHD) power plant containing a plurality of MHD generators arranged in a number of stages is described which operates on a two-phase working fluid consisting of an inert gas dispersed in an electrically conductive liquid. Heat is added to the working fluid by reconstituting the working fluid using conductive liquid heated to the original temperature between stages. All stages are operated essentially isothermally, the last MHD generator being operated under conditions such that vapors of the conductive liquid present in the working fluid are condensed therein. The gas phase from the last MHD generator is cooled by regenerative heat exchange and recompressed prior to being returned to the heat source. Also, each MHD generator is surrounded by a separate magnetic field which is separately adjustable to minimize the velocity difference between phases as the working fluid passes through the MHD generator. (Official Gazette)

22704 ROLE OF THE ELECTRIC RESEARCH COUNCIL TASK FORCE IN THE DEVELOPMENT OF A NATIONAL MHD PROGRAM. Crentz, William L. (Bureau of Mines, Washington, D. C.). Proc. Amer. Power Conf.; 33: 646-8(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The two primary functions of the Electric Research Council Task Force on MHD are to keep the Council advised on the changing technology of MHD in the US and abroad and to recommend to the Council a course of funding action with respect to a jointly funded Government-industry program in MHD. The activities of this Task Force are briefly reviewed. The problem areas in developing a coal-fired MHD system have been reviewed and state-of-the-art reports initiated. Appropriate means of securing non-government funding are being investigated. (L.C.L.)

22705 REVIEW OF THE 50-MEGAWATT EXPERIMENTAL PILOT-PLANT PROGRAM AT AERL. Irving, William (Boston Edison Co., Dorchester, Mass.); Rosa, Richard J.; Hals, Finn A. Proc. Amer. Power Conf.; 33: 649-57(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The MHD program conducted by the Avco Experimental Research Laboratory has included the operation of large generators and the extensive long-term testing of materials for generator ducts and auxiliary equipment. The current objective of the Experimental Pilot Plant (EPP) Program is to design an installation having a large experimental generator of 50 MW capacity whose operation will establish the engineering and operating feasibility of

MHD generators for a variety of applications in electric utility systems. The first year of EPP activity is reviewed. Detailed specifications and a preliminary plant design have been developed, and a cost estimate of the 50 MW installation has been prepared. (L.C.L.)

22706 NUCLEAR THERMIONIC GENERATOR WITH COMPOSITE PARTICLE CATHODE. Weis, Arthur Martin (to Nuclear Materials and Equipment Corp.). U. S. Patent 3,638,051. 25 Jan 1972. Filed 10 Feb 1964.

An invention is described which relates to the art of generating power and has particular relationship to thermionic generators of electrical power. (Official Gazette)

22707 HIGH-TEMPERATURE ATOMIC ENERGY GAS-TURBINE INSTALLATIONS AND COMBINED INSTALLATIONS INCORPORATING A CLOSED-CYCLE MHD GENERATOR. Uvarov, V. V.; Beknev, V. S.; Manushin, E. A.; (and others) (Moscow Technical Coll.). High Temp. (USSR) (Engl. Transl.); 9: No. 4, 748-56(Jul-Aug 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 4, 829-38(Jul-Aug 1971).

The results of a preliminary development of two types of power installations (1200 MW) with a high-temperature nuclear reactor and gas cooling are presented; the first is a gas-turbine installation of the closed-cycle type and the second a combined installation comprising a gas turbine and an MHD generator. The principal data characterizing the component parts and structure of the power stations are presented together with the corresponding technical-economic indices. The closed-cycle gas-turbine installation is intended for operation with a gas temperature of 1200°C in front of the turbine. Two cycles are envisaged: (1) with a single reactor, two intermediate condensers, and a regenerator, and (2) with two reactors, two intermediate condensers, and a regenerator. The efficiency of the cycles is 54.5 and 56.6%, respectively. The combined installation comprising a gas turbine and MHD generator takes two possible forms: (1) with the gas turbine behind the MHD generator, a regenerator, and two intermediate condensers, the gas temperature at the reactor outlet being 1500°C; and (2) with a gas turbine in front of the reactor, a regenerator, and two intermediate condensers, the gas temperature at the reactor outlet being 2000°C. The efficiencies of the cycles are respectively 48.45 and 58.0%. (auth)

22708 CHARACTERISTICS OF PISTON-TYPE LIQUID-METAL MAGNETOHYDRODYNAMIC GENERATORS. Bashkatov, V. A.; Morozov, A. E.; Orlov, P. P.; (and others) (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 4, 741-7(Jul-Aug 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 4, 821-8(Jul-Aug 1971).

On the basis of a thermodynamic analysis and of magnetohydrodynamic theory, two types of generalized dynamic characteristics, written in dimensionless form are proposed which permit an evaluation of the volumetric power, as well as the electromagnetic, kinematic, geometric, and dynamic parameters of special types of piston-type magnetohydromagnetic generators. Based on calculated characteristics for potassium, cesium, mercury, carbon dioxide, water vapor, and a monatomic gas (argon, helium, etc.), the efficiency and the specific volumetric power are evaluated. (auth)

22709 TURNING TURBINES WITH GEOTHERMAL STEAM. Schuster, Ray. Power Eng.; 76: No. 3, 36-41(Mar 1972).

The history of the worldwide use of geothermal energy for power generation is reviewed with emphasis on power generation in Iceland and from the Geysers in northern California. Data are presented on the steam conditions, turbine conditions, condensers, and the electric design of the geothermal power plant at the Geysers. Future plans for developing power plants using natural geothermal steam and geothermal energy released by underground nuclear explosions are mentioned. (L.C.L.)

22710 IMPROVEMENTS IN OR RELATING TO THERMOELECTRIC ELEMENTS AND THEIR MANUFACTURE. Penn, Alan William (to United Kingdom Atomic Energy Authority). British Patent 1,265,318. 1 Mar 1972. Filed 14 May 1968.

The thermoelectric element described comprises a Ge-Si alloy having a fine structure of lattice boundaries for which the characteristic scattering length, defined as the reciprocal of the number of boundaries per unit length, lies in the range from 0.01 to 10 μ, and the proportion of the alloy having this fine structure is such that the element has a thermal conductivity below that of a single crystal of the alloy. The alloy is doped so as to have enhanced thermoelectric properties. At least a proportion of the grains is of size in the range from 0.01 to 10 μ. The method of manufacture comprises hot pressing and cooling the doped powdered alloy to form a unitary structure of the desired properties. (UK)

Facilities and Equipment

Refer also to abstracts 22728, 23226, 23340, 24169–24170, 24185–24187, and 24204.

22711 (TID-25925) REVIEW OF INITIAL STEAM GENERATOR ANALYSIS: LOFT PROGRAM. Herrick, R. Clyde (Franklin Inst. Research Labs., Philadelphia, Pa.). Sep 1967. Contract AT(30-1)-2539. 94p. Dep. NTIS.

For Phillips Petroleum Co., Idaho Falls, Idaho.

Stress analyses of LOFT steam generator components were reviewed to ascertain compliance with LOFT specifications and ASME Boiler and Pressure Vessel Code. The methods, assumptions made, and conclusions for each sub-section analysis were reviewed individually and collectively to see that design and ASME Code requirements had been satisfied. Three regions of the steam generator were found to have stress intensities beyond those allowed by the Code in addition to the one region, the tube-sheet-to-shell junction, acknowledged to be critical for transient thermal conditions following the planned non-nuclear blowdowns. The three regions were: tubesheet during steady-state design primary pressure of 2750 psi at 600°F; primary coolant nozzles during transient thermal conditions following non-nuclear blowdowns; and the secondary vessel shell-to-skirt junction during steady-state pressure and temperature conditions. (L.C.L.)

22712 DEVICE FOR MEASUREMENT OF INTERNAL FRICTION OF SOLIDS. Buschbeck, F. (Reaktorzentrum, Seibersdorf, Austria). Acta Phys. Austr.; 33: No. 1, 19-26 (1971). (In German).

A device for the measurement of the internal friction of solids, based on the decay behavior of a mechanically activated sample, was constructed. The measurement results were independent of the initial amplitude within the linearity range of the measurement circuit. The amplitude values of the first and nth oscillation were fed as analog voltage values to a condenser. The condenser with the initial oscillation value was discharged to zero by a current proportional to the nth oscillation. The time necessary was measured with an auxiliary frequency. The period length was determined with the same auxiliary frequency time difference of two adjacent zero passages of the oscillation. (J.S.R.)

22713 CONCENTRIC FLUIDIZED BEDS. Killian, Douglas C.; Roeh, Arthur P. (to United States Atomic Energy Commission). U. S. Patent 3,633,888. 11 Jan 1972. Filed 19 Feb 1970.

A fluidized bed burner is described which has a center tube defining an inner fluidized bed, constituting a first-stage burner, and an outer tube concentric to the inner tube and spaced radially outward from the inner tube to define an annular-shaped fluidized bed. The upper portion of the center tube wall separating the fluidized beds is perforated to permit a free flow of material between the two beds for improved heat transfer and temperature control. The upper portion of the outer tube extends substantially above the top of the center tube to define a second-stage burner area above the fluidized beds. (Official Gazette)

22714 SHOCK PRESSURE TRANSDUCER. Huddleston, Roy L. (to United States Atomic Energy Commission). U. S. Patent 3,638,160. 25 Jan 1972. Filed 4 Sep 1969.

An improved shock pressure transducer is described in which the improvement consists of a low-resistance connection between a thin vapor-deposited sensor grid and the electrical pins of an encapsulated transducer. The connection in combination with other known parts produces a significant increase in the output of the transducer. (Official Gazette)

22715 STEAM GENERATOR. (to Westinghouse Electric Corp.). British Patent 1,264,521. 23 Feb 1972. Priority date 13 Jun 1968, United States.

A liquid metal heated steam generator is described. The system is designed to include large-volume liquid–metal heated heat exchangers which can be easily assembled and are reliable in operation. (J.R.D.)

22716 APPARATUS FOR MEASURING THE ELASTIC MODULUS AND INTERNAL FRICTION OF A SAMPLE. (to Commissariat a l'Energie Atomique). French Patent 2,067,886. 26 Jul 1971. Filed 20 Nov 1969. (In French).

An apparatus for measuring the elastic modulus and the internal friction of irradiated and nonirradiated samples intended for use at high temperatures is presented. Measurements are made as a function of temperature by determining the resonance frequency. The apparatus consists of an enclosure provided with temperature

and internal atmosphere control devices, an electrode axially displaceable in a rigid tube up to the position of the electronic circuit, devices ensuring the sealing of the tube around the electrode, a cylindrical form sleeve supporting the sample, and a movable carriage supporting the electrode and tube assembly. (France)

Heat Transfer and Fluid Flow

Refer also to abstracts 22927, 23235, 24748, 24757, 24760, 24813, 25027, and 25029.

22717 (ANL–7694) DROPLET TRANSPORT IN TURBULENT PIPE FLOW. Ginsberg, Theodore (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 148p. Dep. NTIS.

Thesis. Submitted to Pennsylvania State Univ., University Park.

Analytical and experimental investigations of the Fick's law diffusion model of turbulent droplet transport are described. The turbulent diffusion model is applied to the transport of liquid droplets in the central core region of fully developed turbulent pipe flow. The Fick's law formulation is defined, and its implications are discussed. The particle diffusivity is defined in terms of the statistical properties of the particulate motion. The momentum equations for a single particle moving in a turbulent fluid are presented. An expression for the particle diffusivity is obtained for the case of a particle falling with terminal velocity greater than the rms turbulent fluid velocity. A study of droplet transport in turbulent pipe flow was carried out. Water droplets, introduced into the center of a pipe, flowed vertically downward and concurrently with the air flow. A droplet generator was fabricated which produced a continuous stream of uniform size droplets with known diameter. Radial distributions of the droplet concentration were measured downstream from the droplet injector. A hot wire anemometer was employed as a droplet concentration sensor. The droplet concentration data were used to extract particle diffusivity information. For each droplet size, Reynolds number and axial measurement station, a least squares analysis yielded a value of the diffusivity. (auth)

22718 (CEA-CONF–1938) CLASSIFICATION OF SEVERAL PROBLEMS OF NATURAL CONVECTION. Vernier, Ph. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 50p. (In French). (CONF-710939–2). Dep. NTIS (U. S. Sales Only).

From Conference on natural and mixed convection and its industrial application; Ermenonville, France (13 Sep 1971).

An attempt was made to classify the various problems of mixed, natural, and forced convection. Terms are defined and the problems are classified into two categories: external and internal. In each of these, the vertical, horizontal, inclined, and spherical problems are considered. During the review, the different methods of prediction by calculation are given and those best adapted for each case are noted. (tr-auth)

22719 (CONF-700567) ROLE OF NUCLEATION IN BOILING AND CAVITATION. Symposium Presented at Joint Fluids Engineering, Heat Transfer, and Lubrication Conference, Detroit, Michigan, May 26–27, 1970. (American Society of Mechanical Engineers, New York). 139p. ASME, New York, N. Y. $22.00.

Papers are included on behavior of liquid Na in pressure fields, bubble formation in flowing streams, heterogeneous nucleation of water vapor in nozzles, properties of cavitation nuclei, vapor bubble collapse in water, nucleation thermodynamics in gas-liquid solutions, bubble growth at solid surfaces, activation in saturated nucleate boiling, heat transfer to film boiling liquid N, bubble nucleation from glass cavities, pool boiling of Freon 113, boiling heat transfer, and two-phase pressure drop. (J.R.D.)

22720 (CONF-711130) PROCEEDINGS OF FOURTH AUSTRALASIAN CONFERENCE ON HYDRAULICS AND FLUID MECHANICS AT MONASH UNIVERSITY, MELBOURNE, AUSTRALIA, NOVEMBER 29–DECEMBER 3, 1971. (Monash Univ., Clayton (Australia)). 625p.

About 87 papers were presented at the conference. A separate abstract was prepared for each of five papers considered to be in scope for NSA. (J.R.D.)

For abstracts of individual papers see: 22721–22724, and 22819.

22721 (CONF-711130–, pp 329-36) NEUTRON FLUCTUATION AND PROPAGATION IN SINGLE AND TWO-PHASE MEDIA. Kemeny, Leslie G. (New South Wales Univ., Kensington (Australia)). 1971.

From fourth Australiasian conference on hydraulics and fluid mechanics; Melbourne, Australia (29 Nov 1971).

The dynamic behavior and stability of nuclear reactor systems are influenced by the hydrodynamic performance of the reactor core coolant circuits. New techniques, based on correlation and spectral analysis and stochastic modeling, are being developed to monitor the flow of single and two-phase coolants. One approach, of considerable promise, is to record and analyze fluctuations in neutron population density at appropriate stations in the nuclear plant. Propagation effects, observed by the use of two detectors, also provide useful physical information which may be utilized to improve system design, safety and control. Some experiments, which have been carried out in this field are described. Equipment used for data acquisition and processing is discussed. Stochastic models are formulated and it is proposed that neutrons be used as "tracers" for the monitoring of hydrodynamic phenomena in non-nuclear environments and in research rigs. (auth) (Australia)

22722 (CONF-711130–, pp 345-51) DYNAMICS OF NON-SPHERICAL VAPOUR BUBBLES. Guy, T. B.; Ledwidge, T. J. (Australian Atomic Energy Commission). 1971.

From fourth Australiasian conference on hydraulics and fluid mechanics; Melbourne, Australia (29 Nov 1971).

An account is given of an experimental and theoretical study of the dynamics of a vapor bubble in sub-cooled water. The bubble is generated by transiently heating a thin constantan steel strip in which a cylindrical nucleation hole exists. A finite element computer solution to the transient, non-spherical growth of the bubble assumes the bubble surface to be inscribed by a large number of spheres of radii equivalent to the average of the principal radii of curvature at a point on the surface. The particular case of axial symmetry is considered here. The change of the surface topology of the bubble with time is taken to be that produced by the corresponding growth or collapse of the generating spheres. It is assumed that under the considered conditions, the energy exchange across the liquid-vapor interface is dominated by mass transfer and thus a considerable simplification in the interfacial energy exchange equations results. The mass transfer across the boundary is coupled to a modified form of the Rayleigh equation in which pressure gradient, surface tension and viscosity terms have been accounted for. The effect of a temperature field on the bubble shape on the acoustic wave emitted by the bubble is examined and shown to be in reasonable agreement with the experimental dynamic pressure measurement. (auth) (Australia)

22723 (CONF-711130–, pp 398-405) NOISE ANALYSIS OF COOLANT DYNAMICS IN TWO-PHASE HEAT TRANSFER SYSTEMS. Romberg, T. M.; Ledwidge, T. J. (Australian Atomic Energy Commission). 1971.

From fourth Australiasian conference on hydraulics and fluid mechanics; Melbourne, Australia (29 Nov 1971).

The identification and characterization of the dynamics of coolant flow in a boiling heat transfer loop are considered as a particular case of system identification using noise analysis techniques. The more applicable parts of general noise theory are summarized and it is shown analytically that if a system approximates to one having a single degree of freedom, then simplification of the noise analysis method is possible. In the preliminary experiments a closed water-loop system was used. The pressure at the inlet to the tubular test section was 55 bar. The maximum heat flux in the test section was about 200 watts cm^{-2}. Measurements intended for detailed data reduction were limited to the inlet flow rate fluctuations and the dynamic component of the pressure drop across the test section. The results were processed using an on-line correlator and an on-line spectrum analyzer. The measured parameters approximated to a Gaussian amplitude distribution. In both measurements the expected low frequency hydrodynamic signals were severely influenced by higher frequency noise sources. The inlet flow rate fluctuations were measured with an orifice plate which generated significant turbulent noise and proved unsatisfactory for detecting the required signals. The test section pressure drop measurements yielded an inverse variance which was a strong function of the test section power, and it is postulated that these measurements can be used to determine the hydrodynamic stability characteristics of the test facility. The present tests do not conclusively confirm the method of analysis outlined in this paper, but they indicate the complexity of two-phase flow dynamics. The various noise sources are being given further detailed study in the current research program. (auth) (Australia)

22724 (CONF-711130–, pp 429-33) RELATIONSHIP BETWEEN THE COHERENCE LENGTH OF A TWO PHASE MIXTURE AND THE RESPONSE OF A CYLINDRICAL CANTILEVER. Harris, R. W.; Ledwidge, T. J. (Australian Atomic Energy Commission). 1971.

From fourth Australiasian conference on hydraulics and fluid mechanics; Melbourne, Australia (29 Nov 1971).

A preliminary examination of the relationship between the coherence or mixing length of a flowing air-water mixture and the response of a solid cylindrical cantilever in axial air-water flow shows that the r.m.s. strain level at the base of the cantilever increased as the void fraction was increased and decreased as λ/L was decreased. λ is the coherence length of the two phase flow and L is the length of the cantilever. There was no obvious dependence of the r.m.s. strain on the values of λ used in these experiments and this result is consistent with theoretical predictions. (auth) (Australia)

22725 (EUR–4558) THEORETICAL ANALYSIS OF THE MASS MIXING FACTOR IN A NEST OF SQUARE CROSS SECTION TUBES. D'Urso, C.; Garro, A. (Fiat, Turin (Italy). Sezione Energia Nucleare. Ansaldo S.p.A., Genoa (Italy)). 1972. 46p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR FB 60,-.

Turbulent diffusion in adjacent channels is examined. A numerical mixing factor definition is given as the index of the increase in the hot channel factor deriving from enthalpy leveling as a result of the mixing phenomenon. The problem is being studied along broader lines with a view to a distribution survey which will be useful for planning. (auth)

22726 (GEAP–10221-9) DEFICIENT COOLING. Ninth Quarterly Progress Report, July 1–September 30, 1971. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct 1971. Contract AT(04-3)-189. 36p. Dep. NTIS.

Nine-rod steady-state critical heat flux (CHF) data were taken at 1000 and 800 psi for comparison with CHF data obtained during transient flow and depressurization. Seventy-seven transient flow and depressurization runs were made, and several plots of transient flow are presented, showing conditions during the transients. The MAYU code has been improved by providing time-history input of flow, pressure, and heat flux, and accommodations for nonuniform axial heat flux. This new code, MAYU-2, shows an improvement over MAYU in the prediction of time to CHF during steam-water depressurization. MAYU-2, and the TRFLOW program, which incorporates an extension of Zuber's void propagation analysis, show excellent agreement with each other and the data for prediction of transient voids in Freon-114. (auth)

22727 (RD/B/N–2117) SOME ASPECTS OF FULLY DEVELOPED TURBULENT FLOW IN NON-CIRCULAR DUCTS. Kacker, S. C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1971. 47p. Dep. NTIS (U. S. Sales Only).

An experimental study of fully developed uniform density turbulent flow in a circular pipe, containing one or two rods located off-center, is described. The friction factor in both cases was found to be approximately 5% higher than the simple pipe friction factor. The shear stress distribution on the rod surface was determined using calibrated boundary layer fences. The normalized shear stress distributions were independent of Reynolds number in the range 3.7×10^4 to 2.15×10^5. Mean velocity measurements were obtained to check the validity of the universal law of the wall near the rod surface. Secondary flow velocities were measured by a hot wire anemometer and integrated to yield the secondary flow stream function. Secondary flow velocities of the order of 1% of the mean velocity were observed. In the gap between the two pins, however, the secondary flow velocities were only 0.5% of the mean velocity. It is demonstrated that the secondary flow cannot be neglected if used to determine the shear stress distribution on the rod surface. (auth)

22728 (TID–12536) INVESTIGATION OF CONTROLLED FLOW SEPARATION IN NOZZLES. Report No. 1205. Rowe, J. R.; Berner, F. (Aerojet-General Corp., Azusa, Calif.). 19 Dec 1956. 53p. Dep. NTIS.

For California Univ., Livermore. Radiation Lab.

Present-day fixed-contour rocket nozzles provide optimum thrust at only one design altitude; they are constant-expansion-ratio devices which sacrifice a substantial amount of thrust, usually at the lower altitudes. Suggestions are presented for realizing some of the potentially available thrust by inducing separation of the low-pressure gas flow from the nozzle walls and allowing higher, near-ambient pressure to act on the downstream portion of the nozzle contour. In addition to the separation-type of thrust improvement, methods of physically varying the nozzle expansion ratio are given. The experimental program to provide tests of these schemes was based upon a theoretical investigation which indicated the gain to be derived from such devices and the feasibility of producing the desired flow separation. A comprehensive theoretical analysis of the compressible laminar boundary-layer produces a means for predicting separation, including effects of the ratio of specific heats of the gas and a streamwise pressure gradient. A similar analysis, based on empirical theories, is presented for the compressible turbulent boundary layer. A calculation was carried through to illustrate the directional trends of these effects. Both the laminar and turbulent conditions of the boundary layer have been considered because it is not at all certain which of these will exist in a specific nozzle at a particular cross section. The nozzles submitted for the experimental program include means for effecting nozzle flow separation by auxiliary fluid-injection jets and slots, annular fences and ramps, and a "ventilated" nozzle. Another separation-inducing scheme entails the use of a porous-wall nozzle through which a secondary fluid is pumped. This process also acts to cool the nozzle and may stabilize the boundary layer as well. Nozzles with telescoping annuli of proper contour are described which allow essentially as many nozzle expansion ratios as there are annuli of the nozzle. A brief description of necessary instrumentation for the experimental program is also included. (auth)

22729 NEGATIVE EDDY DIFFUSIVITIES FOR ASYMMETRIC TURBULENT VELOCITY PROFILES. Maubach, K.; Rehme, K. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Int. J. Heat Mass Transfer: 15: No. 3, 425-32(Mar 1972).

It appears from experimental results that for asymmetric turbulent velocity profiles the locations of maximum velocity and zero shear stress are not identical. The importance of this effect on the calculation of momentum, heat, and mass transfer in non-circular channels and on universal velocity profiles is considered. Work referring to this effect is surveyed. Unpublished results, derived from the critical interpretation of measurements carried out by several authors, are presented. An empirical relation is indicated which allows an estimation of the magnitude of the effect. (auth)

22730 FORCED CONVECTION HEAT TRANSFER IN A CIRCULAR TUBE WITH NON-UNIFORM HEAT FLUX AROUND THE CIRCUMFERENCE. Rapier, A. C. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). Int. J. Heat Mass Transfer.: 15: No. 3, 527-37(Mar 1972).

An analytical solution, based on a simple postulated distribution of the effective thermal conductivity of the fluid, is derived for the temperature variations around the circumference of a circular tube arising from non-uniform wall heat flux. The results are in good agreement with an existing complex numerical solution and in some cases are probably more accurate. The accuracy of both solutions is mainly determined by the accuracy with which the effective eddy diffusivity of heat in the fluid is known. Published experimental data for a nonuniformly heated tube are used to establish the best value. A simple formula for calculating temperature variations around tubes in practical cases is proposed. (auth)

Materials Testing

Refer also to abstracts 22789, 23338, 23382, 24810, and 24988.

22731 (ANL–7895) FAST-NEUTRON RADIOGRAPHY WITH ^{252}Cf. Berger, Harold; Lapinski, N. P. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 20p. Dep. NTIS.

Fast-neutron radiography with ^{252}Cf spontaneous fission neutron sources was investigated using x-ray film direct-exposure methods with either scintillator or hydrogenous intensifier screens; autoradiographic transfer detectors, of which indium and sulfur appeared to present the best possibilities; and track-etch methods with several cellulose nitrate materials. The exposure characteristics of these detectors were determined, and many of the detectors were tested radiographically. For the radiographic tests, emphasis was on observations of rubber and plastic components mounted on a steel base. The best observations, made with plastic-screen-film direct-exposure methods, indicated that only ~3.2 mm of plastic on 1.27 cm of steel could be detected. Somewhat better contrast is indicated on transfer detectors, but geometry and intensity problems imposed limits on the radiographic tests. Much better contrast results were obtained with comparison thermal- and epithermal-neutron, x-ray, and gamma-ray radiographs. The conclusion is that fast-neutron radiography with ^{252}Cf does not appear satisfactory for general radiographic inspection. The technique may prove useful for special situations, such as the inspection of large or radioactive radiographic objects where small, high-intensity sources would offer major advantages. (auth)

22732 PRESENT STATE OF NEUTRON RADIOGRAPHY AND ITS POTENTIAL. Berger, Harold (Argonne National Lab., Ill.). Mater. Eval.; 30: No. 3, 55-65(Mar 1972).

The present state of the art of thermal-neutron radiography as it relates to industrial application is reviewed. Techniques for performing this type of nondestructive test are well developed and available. Commercial neutron radiographic survice can be obtained in several countries. In-house thermal-neutron radiographic facilities in nonnuclear organizations are now going into service. Progress with those facilities will be closely followed as harbingers of the potential growth of thermal-neutron radiography. Predictions concerning the future of this technique are given. (auth)

Nuclear Explosions

Refer also to abstracts 22779, 22783, and 23157.

22733 (CEA-R-4281) STUDY OF THE RADIOLOGICAL RISKS ASSOCIATED WITH THE DISTRIBUTION OF CONTAMINATED GAS. Combet, Maurice; Gerard, Robert (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jan 1972. 20p. (In French). Dep. NTIS (U. S. Sales Only).

The mean and maximum doses to which the consumers of gas may be exposed are calculated, the gas having remained for some time in a cavity created by a nuclear explosion. The incidences of contamination with ^{85}Kr and tritium for gas used domestically, commercially, industrially, and in agriculture were studied in detail. The results indicate that the doses involved are 5,000 times less than the limits admissible for the population. (auth)

22734 (NVO-108) PROJECT CANNIKIN D +30 DAY REPORT. Preliminary Operational and Test Results Summary. (Nevada Operations Office (AEC), Las Vegas). Feb 1972. 28p. Dep. NTIS.

Cannikin, a test of a nuclear device for the Spartan Antiballistic Missile, was conducted at Amchitka Island, Alaska, at 11:00 a.m., Bering Standard Time (BST), November 6, 1971. The device, designed and constructed by the Lawrence Livermore Laboratory (LLL), was emplaced 5,875 feet below the surface and was detonated from a control point on the Island some 23 miles distant. The seismic measurements indicate that the device performed as expected with a yield of less than five megatons. Work has begun to obtain samples of the device debris. This entails drilling back into the shot region to obtain rock samples in which the device debris is incorporated. If the work proceeds on schedule, postshot drilling is expected to be completed by Spring 1972. The analyses of the material obtained are required to evaluate fully the performance of the Spartan warhead. There has been no release of radioactive effluent as a result of Cannikin and no large earthquake was triggered from the detonation. Teleseismically, the shock had a body-wave magnitude of 6.8 and a surface-wave magnitude of 5.7 Cannikin did not produce a measurable tsunami. Bioenvironmental effects were noticeable, but were confined to the Island and the waters immediately around it. Except for slight but noticeable ground motion at Adak and Shemya, no effects have been reported from any off-Island location. (auth)

22735 (PNE-1120) PROJECT PRE-GONDOLA III PHASE III: CONNECTION OF A ROW CRATER TO A RESERVOIR. Redpath, Bruce B. (Army Engineer Explosive Excavation Research Office, Livermore, Calif.). Aug 1971. 19p. Dep. NTIS.

Project Pre-Gondola III Phase III, the connection of a row crater to a reservoir, was executed on 6 October 1969 and was the culmination of several years of cratering experiments in saturated clay shale near Fort Peck, Montana. This experiment used a total of 70 tons of an aluminized ammonium nitrate blasting agent in a row of five charges to remove a barrier between an existing row crater and the Fort Peck Reservoir. The excavation produced by the detonation had a volume of about 63,000 yd^3. The blasting agent appears to have a cratering effectiveness approximately 1.6 times that of TNT. (auth)

22736 (PNE-WW-1) PROJECT WAGON WHEEL. Technical Studies Report. (El Paso Natural Gas Co., Tex.). 31 Dec 1971. 253p. Dep. NTIS.

A compilation of separate reports concerning technical aspects of Wagon Wheel Project is presented. The project represents efforts to develop the use of underground nuclear explosions to stimulate low permeability natural gas reservoirs. The location of the proposed project is the Pinedale Unit natural gas field, Sublette County, Wyoming. Information and discussions are included concerning geology, drilling, hydrology, petrography, rock mechanical properties, reservoir properties, chimney formation, gas production predictions, gas quality, and seismic motion. (J.R.D.)

22737 (UCRL-50163(Pt.6)) PREDICTION OF THE DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. 6. TRANSPORT OF NUCLEAR DEBRIS BY SURFACE AND GROUNWATER. Fisher, H. Leonard (California Univ., Livermore. Lawrence Livermore Lab.). 5 Jan 1972. Contract W-7405-eng-26. 29p. Dep. NTIS.

The surface and ground-water transport of the radionuclides and debris produced by a large-scale nuclear cratering detonation such as might be used in the course of a nuclear excavation project is discussed. The transfer of crater debris to surface-water systems associated with the excavation site as the result of erosion and the subsequent transport of debris, through the combined actions of rainfall and runoff is examined. The Darcy's Law description of groundwater flow is examined showing that in certain geologic situations, the groundwater travel-times and paths predicted on the basis of standard field measurements of aquifer properties, especially the permeability, can be misleading with regard to the movement of a significant portion of the contaminated water. Unless measurements are sufficiently detailed to resolve the effects of deviations from ideal behavior, contaminated water may either arrive where it is expected, but much sooner than expected, arrive where it is not expected at all, or spread and travel in a much broader band than expected, with the concentration front arriving considerably before the peak concentration. (J.R.D.)

22738 (UCRL-51164) POTENTIAL EXPOSURES FROM LOW-YIELD FREE AIR BURSTS. Knox, J. B.; Crawford, T. V.; Crandall, W. K. (California Univ., Livermore. Lawrence Livermore Lab.). 26 Dec 1971. Contract W-7405-eng-26. 23p. Dep. NTIS.

That there is little fallout hazard close to ground zero from free air bursts of tactical nuclear weapons may be true as long as wet deposition is excluded. However, in real operational situations, the option of excluding wet deposition by selecting appropriate meteorology may not be available. Hence it is important to assess the consequences of wet deposition of the airborne radioactive inventory from such detonations. The potential close-in whole-body exposure from external gamma radiation and the thyroid exposure through the forage-cow-milk pathway for hypothetical 1, 10, and 100 kt all-fission air bursts is examined. Results indicate that complete scavenging of the 1-kt cloud, scavenging of the lower 10% of the 10-kt cloud, or scavenging of the lower 1 to 2% of the 100-kt cloud will give infinite external gamma exposure of a few hundred to 1000 Rems 100 km downwind. If wet deposition should occur 1000 km downwind without any previous precipitation scavenging, the potential external gamma exposure is of the order of 1 Rem. The results also indicate large potential thyroid exposures to man by way of the forage-cow-milk pathway from wet deposition of radioiodine (^{131}I). (auth)

22739 (UCRL-73284) NUCLEAR CHEMICAL MINING OF PRIMARY COPPER SULFIDES. Lewis, Arthur E.; Braun, Robert L. (California Univ., Livermore. Lawrence Livermore Lab.). 27 Jan 1972. 32p. (CONF-720204-3). Dep. NTIS.

From 101st annual meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers; San Francisco, Calif. (20 Feb 1972).

A contained nuclear explosion is proposed to produce a chimney of broken ore well below the water table. After the chimney is filled with water and reaches hydrostatic equilibrium, oxygen, under pressure, is introduced near the bottom of the mass of broken rock. The increase in solubility of oxygen at high hydrostatic pressure is sufficient to initiate the oxidation of the primary sulfides: chalcopyrite and pyrite. The oxidation and dissolution of these sulfides produces enough heat to increase the temperature of the ore and water in the chimney as much as 100 to 150°C. The rate of dissolution of chalcopyrite becomes so rapid under these conditions that the rate of recovery is no longer limited by the rate of chalcopyrite dissolution, but by the degree of exposure and other factors. Means of solution control and distribution of oxygen in the chimney have been examined in some detail. A calculational model utilizing experimentally determined solubility rates is utilized to estimate the temperature rise in the chimney and the rate of copper recovery as a function of initial temperature, sulfide content of ore, size of sulfide particles, and fraction of sulfide exposed to solution. It is concluded that the high pressure and high temperature obtainable in a large ore mass broken by nuclear explosives promise the rapid and economic recovery of minerals not considered soluble by conventional in-situ leaching methods. The method should be broadly applicable to the kinds of deep deposits that must be depended on for future production and with minimum disruption of the environment. (auth)

22740 (UCRL-73611) ECONOMICS AND SAFETY OF NUCLEAR CHEMICAL COPPER MINING. Higgins, Gary H. (California Univ., Livermore. Lawrence Livermore Lab.). [1971]. 18p. (CONF-720204-2). Dep. NTIS.

From one hundred-first annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers; San Francisco, Calif. (20 Feb 1972).

Nuclear solution mining of copper appears economically competitive with other copper production methods, providing suitable ore bodies are found. Such bodies should not be too close to large population centers, extensively developed mines, or industrial facilities because explosions larger than about 60 kt are required. The deposits must be deeper than about 1200 ft to assure containment of the nuclear explosion products and to provide sufficient hydrostatic head to maintain adequate oxygen concentrations. Grades as low as 0.3% copper are sufficient for reasonable return of the investment if the deposit contains 30 million tons or more of ore. This copper production method does not generate volatile oxides of sulfur, the copper product will not be contaminated, and while there are safety problems that come from radioactivity and ground shock, the consequences are quite manageable and inexpensive. If applied, this method would clearly extend domestic copper reserves and deeper, more disseminate domestic deposits should be recovered competitively with politically uncertain foreign copper. The gross capital requirements (about $16 million) of this kind of copper production facility should be less by ten-fold than more conventional facilities. This should make financing less difficult and provide smaller operators a competitive opportunity in copper production. (auth)

22741 METHOD FOR ESTIMATING EFFECTIVE POROSITY IN A RUBBLE CHIMNEY FORMED BY AN UNDERGROUND NUCLEAR EXPLOSION. Garber, M. S. U. S., Geol. Surv., Prof. Pap.; No. 750-C, 207-9(1971).

Explosion of a nuclear device underground at the Nevada Test Site produced a rubble chimney which was completely dewatered at the time of its formation and required a period of about 5 years for infill to the preexplosion water level. Numerous pumping tests conducted during the period of infill of the chimney disclosed that pumping often caused an interruption in the rise of water level in the chimney. A method was devised for estimating the effective porosity of the chimney in selected zones by comparing the volume of water removed during a pumping test with the observed interruption in water level rise resulting from infill. The porosity of the rubble chimney, determined by this method, is between 1.5 and 7.9 percent. (auth)

22742 VARIATIONS IN AUSTRALIAN UPPER MANTLE STRUCTURE, FROM OBSERVATIONS OF THE CANNIKIN EXPLOSION. Cleary, J. R.; Simpson, D. W.; Muirhead, K. J. (Australian National Univ., Canberra). Nature (London); 236: No. 5342, 111-12(17 Mar 1972).

The use of portable seismic stations, that can operate unattended for long periods, enabled a study of the variation of P time anomalies across the eastern boundary of the Australian shield, employing the nuclear explosion Cannikin as a signal source. Deductions are made regarding upper mantle structure. (UK)

22743 IN SITU PRESSURE LEACHING METHOD. Lewis, Arthur E. U. S. Patent 3,640,579. 8 Feb 1972. Filed 28 Apr 1970.

A nuclear chimney located below the water table in a primary ore deposit serves as an in situ pressure vessel in which ore can be oxidized and a desired element contained in the ore subsequently recovered in a leach solution. After the nuclear chimney is flooded with water under substantial hydrostatic pressure, oxidizing gas is percolated through the contained ore and water mixture to dissolve and oxidize the ore minerals. Ammonia may be added with the oxidizing gas to render the solution basic. The solution is pumped from the chimney and may be recirculated with or without heating until the desired concentration is obtained. The oxidizing gas may also be heated prior to its introduction into the chimney. (Official Gazette)

Detection Systems

Refer also to abstracts 22916 and 22917.

22744 NUCLEAR EXPLOSION SEISMOLOGY: IMPROVEMENTS IN DETECTION. Wick, Gerald. Science; 175: No. 4026, 1095-7(10 Mar 1972).

Developments in nuclear explosion seismology are discussed in relation to the effect of negotiations for a comprehensive nuclear test ban treaty on the need for improved detection methods; the basic principles of seismic wave propagation from earthquakes and underground explosions; research since the mid-1960's on seismic event detection and underground explosion concealment; and the worldwide deployment of seismographic arrays. Although it is conceded that a 100% reliable seismic detection system is unlikely to be achieved, it is concluded that the present seismic system is capable of detecting all but the smallest explosions and this technical capability coupled with satellite surveillance and conventional intelligence should assure compliance with a test ban treaty. (L.C.L.)

Civil Uses

Refer also to abstract 22709.

22745 (USGS-474-91) HYDRAULIC TESTING OF THE OJO ALAMO SANDSTONE IN HOLE GB-3, PROJECT GASBUGGY, RIO ARRIBA COUNTY, NEW MEXICO. Gasbuggy-5. Weir, J. E. Jr. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 26p. (PNE-G-76). Dep. NTIS.

Hydraulic tests were made August 24 to September 2, 1969, in the Ojo Alamo Sandstone of Cretaceous age in hole GB-3, drilled about 20 months after the Gasbuggy explosion. The tests were made to determine whether increases in fracture permeability occurred as a result of the Gasbuggy experiment to stimulate gas production from a low yield reservoir by a nuclear explosion. The lower part of the formation, 3,564 to 3,686 feet below ground level, had a transmissivity (T) of 1.56 gallons per day per foot. Comparing this value with the value for T (2.64 gallons per day per foot), determined before the explosion for virtually the same stratigraphic interval in hole GB-1 in February 1967, suggests either that the Gasbuggy experiment fractured none of the lower Ojo Alamo Sandstone at hole GB-3 or that fracturing was insufficient to manifest itself through a permeability increase. A water sample from hole GB-3, as compared to a sample collected prior to the explosion from the same interval in hole GB-1, indicates a slight increase in radioactivity following the Gasbuggy experiment. (auth)

Protective Structures and Equipment

22746 (GKSS-71/E/5) HOT LABORATORY AT THE GEESTHACHT REACTOR STATION. Borchers, F.; Spalthoff, W.; Wittstock, D. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 41p. (In German). (CONF-710618-4). Dep. NTIS (U. S. Sales Only).

From thirteenth Euratom Hot Laboratory meeting; Juelich, Germany (24 Jun 1971).

The design and operation of the hot laboratory at the reactor station Geesthacht is described. The laboratory is comprised of four concrete cells for the handling of high activities up to 5 megacurie and γ energies of 1 MeV. In addition, 10 lead cells are available for mechanical, chemical, and metallographic studies of materials. The irradiation inserts of the two Geesthacht research reactors as well as irradiated fuel elements from the Otto Hahn reactor are studied in the laboratory. (tr-auth)

22747 (NACAR-10024) INVESTIGATION OF IODINE DECONTAMINATION FACTOR AT DIFFERENT CONDITIONS. Kovach, J. L. (North American Carbon, Inc., Columbus, Ohio. Research and Development Dept.). 4 Jan 1972. 19p.

The $CH_3{}^{131}I$ decontamination factor (DF) versus carrier gas velocity effects were evaluated for different particle size carbons at residence times of 0.1 to 0.4 seconds. The data shows a very significant improvement in DF with increasing gas velocity, particularly at residence times above 0.3 second. The particle size dependence of the DF decreases with increasing residence times at high velocity. Similar results were deduced for elemental iodine from literature data. The advantage of coarse carbon, deep beds operated at high carrier gas velocity is discussed. (auth)

22748 (ORNL-TM-3664) BLAST SHELTER POTENTIAL IN NEW GOVERNMENT BUILDINGS. Cristy, George A. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 245p. Dep. NTIS.

A survey was made of the building programs of the major federal agencies to locate and identify below-ground floor space in buildings in the design or early construction phase. Data was collected and analyzed to evaluate the potential for upgrading the federal civil defense shelter program through blast slanting of all new government buildings. The criterion assumed for blast slanting was protection from initial effects including blast, thermal, and initial nuclear radiation experienced at the 15 psi over-

pressure region from a one megaton weapon with no blast closure provided. Assuming that the building programs of the federal agencies for the next decade would follow the same pattern that existed the last five years as regards location, size, and type of construction, and assuming all underground floor space could be blast slanted for $60 per shelter space, the result would be the production of only three-fourths of a million blast shelter spaces during the decade. This represents a differential cost of four and one-half million dollars per year. This cost is less than one percent of the federal building construction budget each year. The survey assembled and displayed data on geographic location, construction cost, and blast slantable spaces in 87 federal government buildings being designed and/or built by the General Services Administration, the Veterans Administration, and the Atomic Energy Commission. The geographic locations of these buildings were examined in comparison with data from previous studies. It was found that except for a few locations in the center of very large cities, the potential shelter spaces in federal buildings located by this survey would provide shelter space to population that would not already have been provided blast shelter space by the earlier proposed programs of utilizing PV 71-81 shelters and blast slanting of transportation structures. (auth)

22749 DESIGN STANDARDS FOR BUILDING HANDLING RADIOACTIVE SUBSTANCES. STUDIES ON HIGH EFFICIENCY AIR FILTER. Sekine, T. (Building Research Inst., Tokyo). Kenchiku Kenkyusho Nenpo; No. 44, 461-3(Dec 1970). (In Japanese).

In order to obtain data on design standards for radioactive installations, studies have been made on dust removal by domestic high-efficiency air filters and performance testing methods. For this purpose an air-borne particle monitor by Royco was tested in which light scattering by minute dust particles is used to measure the particle diameters by photoelectric conversion. Domestic as well as foreign high-efficiency air filters are sufficient for removing atmospheric dusts. The testing method used, though it is not very accurate, is convenient for assessing filter efficiency. When dust concentration is high, however, it is necessary to introduce air into it for dilution. (Japan)

22750 PROTECTION AGAINST INTENSE LIGHT. II. THE ROLE OF THE GASEOUS DECOMPOSITION PRODUCTS. Prosser, R. A.; Stapler, J. T. (Army Natick Labs., Mass.). J. Appl. Polym. Sci.; 16: No. 3, 573-83(Mar 1972).

Screening studies have shown that of a series of halogenated vinyl polymers, poly-(vinylidine fluoride) gives comparatively good thermal protection when exposed to the intense light energy of the carbon arc-image furnace. Results indicate that this protection is undoubtedly provided by polyenes, $-(CH=CF)_n-$, formed during pyrolysis. Decomposition products containing these structures are expelled by the gases formed into the region between the light source and the target where they intercept photons from about 200 to 500 mμ and dissipate the energy to the air as heat and/or reirradiate it. Instrumental evidence for polyene formation is given. The concept of polyene formation clarifies the relative thermal protection offered by a series of vinyl polymers. (auth)

Safety Engineering

Refer also to abstracts 22817, 24786, 24829, and 24913.

22751 (JUL-787-ST) 1970 ANNUAL REPORT OF THE CENTRAL DIVISION OF RADIATION PROTECTION. Keller, M.; Tzschaschel, R. (eds.) (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Sep 1971. 190p. (In German). Dep. NTIS (U. S. Sales Only).

The Zentralabteilung Strahlenschutz (ZST) of the Nuclear Research Establishment, Juelich, is responsible for an adequate and a proper performance of the radiation protection programs for personnel, installations, and the environment in West Germany. This includes the introduction of the necessary organizations as well as the permanent development of measuring methods and procedures according to the most recent knowledge of science and research. Activities during 1970, as well as the results of investigations and developments in connection with the improvement of methods and procedures, are reported. A complete bibliography of the published and internal literature of the ZST in 1970 is included. (auth)

22752 (LA-4860) RISK vs BENEFIT: SOLUTION OR DREAM. Otway, Harry J. (ed.) (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 65p. (CONF-711123). Dep. NTIS.

From Symposium on risk vs benefit analysis: solution or dream; Los Alamos, N. Mex. (11 Nov 1971).

A compendium of papers prepared by personnel from the nuclear industry, nuclear critics, and representatives from the AEC laboratories is presented. Information is included on social acceptance of nuclear energy, risk-benefit analysis, aspects of nuclear Cu mining, decision making, mental limitations of man, and goals of cost–benefit analysis. (J.R.D.)

22753 (NP-19174) WORK INJURIES IN ATOMIC ENERGY, 1969. A SURVEY OF PRIVATELY-OWNED AND-OPERATED ESTABLISHMENTS. Report 385. Schauer, Lyle R. (Bureau of Labor Statistics, Washington, D. C.). 1971. 13p.

During 1969, injuries to personnel of privately owned and operated atomic energy (AE) establishments in the USA occurred at a rate of 4.0 injuries per million hours worked, or about eight injuries per 1,000 employees. This is a decline from the rate of 4.3 per million hours worked in 1968. However, the lower rate does not necessarily indicate improved safety conditions. More likely, it was due to establishments which had better safety records being included in the more recent survey. In fact, establishments which were included in both the 1968 and 1969 surveys reported an injury-rate increase from 4.2 to 4.3. The injury-frequency rate for AE establishments was low compared with the rates resulting from the BLS-national and National Safety Council (NSC) surveys. In 1969, the rate of AE establishments engaged in manufacturing was 4.1, the BLS-national manufacturing industry rate, 14.8; and the NSC manufacturing rate, 5.3. AE establishments tend to be either large firms or constituent parts of large firms concentrated in industries which produce heavy durable goods. Such establishments usually have strong safety programs which result in low injury rates. Even though the overall injury rate for AE establishments is low, some establishments had quite high rates, (10 percent of the establishments had a rate equal to or higher than 16.3) and could benefit from improved accident-prevention efforts. AE establishments are classified into segments according to their economic activity. Three segments, reactor design and manufacturing; design and engineering of nuclear facilities; and nuclear instrument manufacturing, account for over three-fourths of the hours during which employees were exposed to the hazards of the workplace. The injury experience of these three segments, therefore, strongly influences the overall injury rate of AE establishments. The average seriousness of injury, measured by the average number of days charged per injury, was 73 days for the BLS–AEC survey, higher than the average for the BLS-national survey (49 days), but lower than the NSC survey (79 days). The severity rate, the number of days lost per million employee-hours worked, was 292 in 1969. This rate is lower than the rate reported in the NSC survey (640) or the BLS manufacturing rate (730). The severity rate for the BLS–AEC survey was lower than either the NSC or BLS-national surveys, even though the average seriousness of injury in the BLS–AEC survey was high. The apparent contradiction of these indicators was the result of the low frequency of injuries in AE establishments. The severity rate is influenced strongly by the frequency of injuries as well as their average seriousness. The frequency of injury in AE establishments was considerably lower than either of the other surveys, resulting in a lower severity rate. None of the disabling injuries reported was characterized by clinically evident biological damage resulting from radiation. (auth)

22754 SYRINGE RADIATION SHIELD FOR SHORT-LIVED RADIONUCLIDES. Leonard, P.; Royle, R. A. (Repatriation General Hospital, Concord, Australia). Australas. Radiol.; 15: No. 3, 299-301(Aug 1971).

Structural details are given of radiation shields for 1 and 2 ml syringes used for injecting short-lived radionuclides. (Australia)

22755 FILTER SYSTEM DESIGN, INSTALLATION, AND TESTING FOR RADIOACTIVE CONTAMINANT REMOVAL. Kovach, J. Louis (North American Carbon, Inc., Columbus, Ohio). Contam. Control; 10: 9-14(May-Jun 1971).

It is noted that many currently used filter systems are unsatisfactory for removal of radioactive particulates and gases. Aspects of filtration and errors in filter design and operation are discussed. Information is included on predesign checklists, contaminants to be removed, moisture removal, design criteria for radioactive contaminant removal, filter installation, and filter testing. (J.R.D.)

22756 PROTECTIVE BARRIER FOR USE WITH THE ^{90}Sr OPHTHALMIC BETA-RAY APPLICATOR. Ward, Robert H. (Union Univ., Albany); Moore, Booker T. Trans. Amer. Acad. Ophthalmol. Oto-Laryngol.; 75: 656-9(May-Jun 1971).

Shielding is described for use in observing the active surface of $^{90}Sr-^{90}Y$ ophthalmic β applicator while preparing it for operation. Plexiglas is used because of its safety and stability. Shield dimensions are based on anticipated radiation doses; then tested.

Data tables are included on dose rates of $^{90}Sr-^{90}Y$ applicator through various thicknesses of Plexiglas. The use of Lucite instead of Plexiglas is noted. (J.R.D.)

22757 INDUSTRIAL HYGIENE CONTROL OF A URANIUM SHEARSPINNING OPERATION. Foster, F. J. (Philco-Ford Corp., Newport Beach, Calif.). Amer. Ind. Hyg. Ass. J.; 32: No. 12, 786-9(Dec 1971).

Metal shearspinning is one of the oldest of metal-forming processes, dating back to the Egyptian production of copper pots and bowls approximately 3000 years ago. Modern uranium shearspinning is an efficient method of precision metal forming which produces very little airborne contamination. A total of 98 air and wipe samples taken to date have revealed no excessive concentrations. Air samples were collected on Whatman 41 filter paper utilizing Staplex Type TFIA and ICN Model 8000 high-volume air samplers and the MSA Monitaire personal air sampler. The average breathing zone concentration was less than 5×10^{-3} μCi/ml. Samples were analyzed for alpha radiation in an alpha scintillation counter. In addition to monitoring of indoor and outdoor air concentrations, the control program plan included special facility design and construction, personnel medical clearance and surveillance, protective clothing, and control of waste products. Intermittent operation of the facility over the past two years has occurred without major incident. It is concluded that the control techniques outlined have been successful. (auth)

22758 IMPACT OF TRITIUM ON THE WATCH INDUSTRY, 1966–1970. Bradley, F. J.; Blais, R.; Jones, A. (New York State Dept. of Labor, N. Y.). Radiol. Health Data Rep.; 12: No. 12, 601-10(Dec 1971).

Tritium contamination from self-luminous watches at wholesale importers, retailers, and refinishers was investigated. Air, surface-wipe, and urine samples were analyzed for ^{3}H content by liquid scintillation counting to determine the extent of the contamination. Eleven storage vaults were surveyed, and the highest human exposure (0.5 rem per year) was found in a firm which handled approximately 200 Ci/y and had poor vault ventilation. Contamination was negligible in vaults at retail establishments. The casing and repair areas of a firm which handled more than 100 Ci/y had air, surface, and human contamination values of 0.063 pCi/cm^3, 11,200 pCi/100 cm^2, 0.48 μCi/liter, and 0.039 pCi/cm^3, 7,820 pCi/100 cm^2, and 0.22 μCi/liter, respectively, on a yearly average. The casing and repair areas of a firm which handled about 10 Ci/y had air, surface, and human contamination values of background, 430 pCi/100 cm^2, and 0.08 μCi/liter, and background, 807 pCi/100 cm^2, and 0.05 μCi/liter, respectively, on a yearly average. A refinisher who handled an estimated 30 to 50 Ci/y had air, surface, and human contamination values of background, 33,600 pCi/100 cm^2 (near stripping solution), and background, respectively, on a yearly average. (auth)

22759 NUCLEAR SAFETY. VOLUME 13, NUMBER 2. Cottrell, Wm. B.; Blakely, J. P.; Jordan W. H. One of Four Technical Progress Reviews Published for the Technical Information Center, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Mar-Apr 1972). 85p. GPO $0.60.

Separate abstracts were prepared on nine papers related to nuclear safety. (C.H.)

For abstracts of individual papers see: 22760–22761, 23165, 23435, 24786, 24820, 24829, and 24916–24917.

22760 STRUCTURAL EFFECTS OF CONFINED DYNAMIC LOADS. Habip, L. M. (General Tech. Corp., Lawrenceville, N. J.). Nucl. Safety; 13: No. 2, 107-13(Mar-Apr 1972).

This review of modern methods of design and analysis in the field of structural effects of dynamic loads stems from current needs to ensure the containment of chemical reactions that may accidentally occur in liquid-metal-heated steam generators associated with certain nuclear power plants. It is recommended that the design of cylindrical vessels subjected to transient internal pressures be based on the amplitude–impulse plane representation of the dynamic bursting criterion. Methods available for application to the problem under consideration are dynamic limit analysis and finite-difference analysis, with brief mention of recent developments in finite-element methods. (auth)

22761 ASME CODE QUALITY-ASSURANCE PROGRAM FOR NUCLEAR REACTORS. McGuffey, J. R. Nucl. Safety; 13: No. 2, 99-103(Mar-Apr 1972).

To enhance the safety and reliability of vessels, pumps, valves, and piping used in nuclear power systems, the ASME Boiler and Pressure Vessel Code has set forth specific quality-assurance (QA) responsibilities for the owner, the manufacturers, the installers, the ASME, and authorized inspection agencies. In particular, the manufacturers and the installers of such components must operate under a controlled manufacturing system and under detailed QA programs. This approach to controlling the design, fabrication, and installation of nuclear components during the past 3 years has materially improved the integrity of nuclear pressure-boundary and pressure-containing systems. (auth)

Vacuum Engineering

22762 (UCRL-Trans-10584) ULTRA-VACUUM PRODUCTION BY DEPOSITING TITANIUM ON A COLD SURFACE. PART I. SCIENTIFIC BASE. PART II. TECHNOLOGY AND APPLICATION. Prevot, F.; Sledziewski, Z. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Vide; 23: No. 133, 1-14(Jan–Feb 1968). 25p. Dep. NTIS.

Abstracts of these papers, prepared from the original language, appeared as NSA 22: 16835 and 22: 16836.

22763 APPLICATION OF VACUUM TECHNOLOGY TO GAS FILLED RADIATION DETECTORS. Goodings, A.; Jaques, T. A. J.; Allen, F. H.; Mauger, R. A.; McMinn, K. W. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Vacuum; 21: No. 11, 515-22(Nov 1971).

Gas-filled radiation detectors are used as components of the control systems for nuclear reactors and are usually vital to safe and efficient operation. They rely on electron and ion collection processes between insulated electrodes in a gas-filled vessel and depend significantly on the gas purity and insulator quality. Insulation values up to 10^{10} Ω at 1000 V and 550°C may be required over a continuous life of at least 3 yr. This performance must be achieved in hostile environments which, in addition to radiation, may include high external pressures. Some of the electrodes must be coated with neutron sensitive deposits such as boron and uranium. The former is normally painted from an oil suspension and presents relatively heavy loads to pumping equipment. It also provides a rich source of insulator contaminant. The main constructional materials are stainless steel in both normal and special, low manganese forms, titanium and aluminium. Alumina and synthetic sapphire are employed as insulants. Signals generated by radiation detectors are measured via flexible polythene cables wherever possible but, where high temperatures or high radiation levels exist, mineral insulated types are essential. Studies have been made of the pumping and outgassing performance of such cables. Variation in the properties of apparently identical detector constructions led to consideration of the actual purities of gas fillings. Residual gas analyzers are now used for monitoring purposes. Ultrahigh vacuum conditions are clearly desirable because ultra clean processes and end products are required but it is noted that low pressures are not necessary per se. Thus, filling and processing systems tend to use valves, pressure gauges, transducers and other components which are bakeable but which may be of low pumping speed and therefore relatively cheap. (auth)

22764 MEASUREMENT OF HELIUM LEAKS 10^{-5} TIMES BETTER THAN THE SENSITIVITY OF A MASS SPECTROMETER LEAK DETECTOR. Verheyden, L.; Klein, K.; Croue, C. (CCR-EURATOM, Ispra, Italy). Vacuum; 21: No. 11, 545-9(Nov 1971).

The actual limit of helium leak detection is given by the highest sensitivity to helium of a mass spectrometer leak detector and can be considered to be 10^{-10} atm cc/sec. The output of such a leak detector is strongly influenced by the vacuum created at the height of the spectrometer tube. A method is proposed which permits the range of leak measurements to be extended by a factor of 10^{-5} over the actual limit of mass spectrometer leak measurements. The method is based on the accumulation of a leak, compared with the accumulation of a background over the same time. The rather complex manipulations are explained and justified. (auth)

22765 LARGE Ti SUBLIMATION PUMP. Prevot, F. (EURATOM–CEA, Fontenay-aux-Roses, France. CEA, Fontenay-aux-Roses, France); Sledziewski, Z.; Aubry, B.; Delafosse, J. Vide; 26: No. 153, 91-4(May 1971). (In French).

A Ti sublimation pump with a cold surface is described. Tests carried out on this pump are discussed. The use of two of these pumps is envisaged at the space simulation chamber of the National Space Research Center at Toulouse. The pump is 3m in diameter and 4m high. The liquid N-cooled surface has an area of 18 m^2, which leads to an internal pumping speed of about 2×10^6 l/s, the conductance of the pipe connecting it to the chamber limiting the external flow to about 10^5 l/s. Continuous pumping between 10^{-6} and 10^{-9} torr is possible. The maximum operating potential is 10^{-3} torr and the limiting pressure is less than 10^{-9} torr; 2 kg of Ti enables continuous pumping to be carried out over a period of 2000 hours with a gas flow of 0.4 l torr/s. (France)

ENVIRONMENTAL AND EARTH SCIENCES

22766 ENVIRONMENTAL CHEMISTRY OF CADMIUM IN AQUEOUS SYSTEMS. Posselt, Hans Siegfried. Ann Arbor, Mich.; Univ. of Michigan (1971). 189p. University Microfilms Order No. 72-4955.

Thesis.

An experimental study of the aqueous chemistry of cadmium pertaining to control of the pollution of natural waters and drinking waters by this metal is described. Elements of the study are formulation of species distribution and equilibrium solubility diagrams for cadmium in complex aqueous systems; removal of cadmium by precipitation from alkaline carbonate solutions; removal of traces of cadmium by sorption on hydrous metal oxides; and entrance of cadmium into drinking water distribution systems by corrosion of galvanized pipe coatings. Isotope techniques with ^{115m}Cd were employed for kinetic and equilibrium measurements, with activities determined by Cerenkov counting of aqueous samples. Results of studies on the precipitation of cadmium from alkaline carbonate systems indicate competition between formation of $Cd(OH)_2$ and $CdCO_3$. The general kinetic pattern reveals a rapid initial and slow secondary rate component. Quantitative and rapid removal of cadmium is realized in precipitation systems having high carbonate/hydroxide ratios. These conditions coincide with the pH range (9.3 to 10) of minimum solubility for cadmium in carbonate precipitation controlled systems. Anion and ionic strength effects on the rate of precipitation are relatively weak and appear insignificant for most wastewater treatment operations. A substantial overall rate acceleration was found for precipitation systems seeded with pre-formed particulate cadmium carbonate. The sorptive uptake of cadmium on dispersed hydrous oxides of Mn(IV) and Fe(III) is rapid. The selectivity and the ultimate capacities of the oxides for cadmium are high. Equilibrium conditions for sorption are described well by the Langmuir equation. Limiting sorption capacities (X_m values) increase beyond the pH of zero point of charge (ZPC) for both oxides. On the basis of X_m and ZPC values, hydrous manganese dioxide is superior to the hydrolysis products of Fe(III) as a cadmium sorbent. A relatively high sorption affinity for cadmium is indicated by small ionic strength effects and weak sorption competition by calcium. Sorption on hydrous oxides of Mn(IV) and Fe(III) is suggested as a feasible method for removal of trace amounts of cadmium from drinking water supplies. The corrosion of cadmium in water at pH 8.3 to 10.6 proceeds under cathodic control via reduction of oxygen. The cathodic process is rate limited by transport of oxygen to the corrosion site over a wide range of conditions. The corrosion rate falls off rapidly with increasing pH, concentration of carbonic acid species, and in the presence of sodium metasilicate. The inhibiting effect of OH^-, CO_3^{2-}/HCO_3^-, and metasilicate is interpreted in terms of film formation. Precoating of the metal in solutions containing these species amplifies this effect. Formation of surface films is further evidenced by a substantial increase in corrosion rates observed by galvanic coupling of cadmium with copper. A quantitative treatment and mechanistic interpretation of the data is presented, and criteria of practical significance for the control of cadmium in the aqueous environment are discussed. (Diss. Abstr. Int., B)

22767 GEOLOGICAL SURVEY RESEARCH, 1971. U. S., Geol. Surv., Prof. Pap.; No. 750-A, 1-418(1971).

A summary is presented of recent significant scientific and economic results in geologic research and is accompanied by a list of publications released in fiscal year 1971, a list of geologic and hydrologic investigations in progress, and a report on the status of topographic mapping. Information is included on: resources investigations (geologic, geophysical, mineral, and water); geologic and hydrologic principles, processes, and methods; engineering and public welfare uses of geologic and hydrologic research; astrogeology; remote sensing and advanced techniques, and investigations in other countries. (L.C.L.)

22768 GEOLOGICAL SURVEY RESEARCH, 1970. U. S., Geol. Surv., Prof. Pap.; No. 700-A, 1-426(1970).

A summary is presented of recent significant scientific and economic results in geologic research and is accompanied by a list of publications released in fiscal year 1970, a list of geologic and hydrologic investigations in progress, and a report on the status of topographic mapping. Information is included on: resources investigations (geologic, geophysical, mineral, and water); geologic and hydrologic principles, processes, and methods; engineering and public welfare uses of geologic and hydrologic research; astrogeology; remote sensing and advanced techniques; and investigations in foreign countries. (L.C.L.)

Minerals and Ores

Refer also to abstracts 22739–22740, 22743, 22793, and 22901.

22769 THORIUM- AND TITANIUM-BEARING ORGANIC MATERIAL IN THE DAKOTA SANDSTONE NEAR DURANGO, COLORADO. Houston, Robert S.; Murphy, John F. U. S., Geol. Surv., Prof. Pap.; No. 700-C, 138-44(1970).

Organic material similar to thucholite is present in the Dakota Sandstone at a locality north of Durango, Colo. The organic material resembles asphaltite in the field, but results of chemical analyses suggest that it was derived from coal or humic substances. It is especially enriched in Th and Ti, but also contains anomalous amounts of Au, U, Nd, Zr, Yb, Y, V, Sr, La, Cr, Cu, Ba, and Ce. Heavy minerals in the Dakota Sandstone at this locality probably are inadequate to supply the elements present in the organic material. Because of the variable chemical properties of the elements enriched in the organic material and the tendency of certain of the elements, such as Th, Ti, and Zr, to precipitate with the hydrolyzates, it seems unlikely that these elements would be transported in a single ionic solution to the organic material where they could be adsorbed to form thucholite. It is suggested that ground water carried humic substances in solution or as colloidal suspensions through the Dakota Sandstone and that these substances adsorbed the various elements from local interstitial solutions or surface films on minerals of the sandstone. (auth)

22770 EFFECT OF MICROORGANISMS ON THE STRUCTURE OF URANIUM RAW MATERIALS. Barbic, F. (Inst. for Tech. of Nuclear Raw Materials, Belgrade); Krajincanic, Branka. pp 279-81 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

The present preliminary studies describe the possibility of extracting uranium from raw material by microorganisms. The studies include the isolation and determination of the location of the microorganisms in the mineral ore. A comparison of the ecophysiological properties of the isolated types of microorganisms from different locations permits us to elucidate the conditions of uranium extraction from the ore by microorganisms. The results obtained show that the bacteria belonging to the genera Thiobacillus and Ferrobacillus exist in natural ore and in the water from mines. The possibility that a higher percentage of uranium can be extracted from the previously treated mineral was also indicated in the biological assay. (auth)

22771 GEOCHEMICAL PROSPECTING FOR THORIUM VEINS BY STREAM-SEDIMENT SAMPLING, LEMHI PASS QUADRANGLE, IDAHO AND MONTANA. Staatz, Mortimer H.; Bunker, Carl M.; Bush, Charles A. U. S., Geol. Surv., Prof. Pap.; No. 750-C, 136-40(1971).

In an area that contains many thorium veins, samples of stream sediment were collected to determine whether the thorium content of the samples would aid in locating these veins. The thorium content of most of these samples ranges from 6 to 20 ppM. The wide range of thorium values is due in part to the relatively low thorium values of samples collected from streams that drain areas underlain by Challis Volcanics in contrast to higher thorium values in samples collected from streams that drain areas underlain by rocks of the Belt Supergroup in which all the known thorium veins were found. Thorium values of four samples that were collected a short distance downstream from mine dumps on thorium veins are clearly above all background values. A comparison of the thorium content of other samples along some streams shows small increases in the thorium content of some samples collected close to and downstream from thorium veins. (auth)

22772 URANIUM CONTENT OF PEATY SOILS RICH IN MOLYBDENUM AND SELENIUM FROM CO. LIMERICK, EIRE. Williams, C.; Brown, G. (Rothamsted Experimental Station, Harpenden, Eng.). Geoderma; 6: No. 3, 223-5(Nov 1971).

Peaty soils from Kilcolman, Co. Limerick previously shown to contain anomalously large amounts of selenium and molybdenum contain up to 550 ppM uranium and 150 ppM bromine. The uranium probably derives from the Clare Shales and is likely to have been concentrated on the peat from drainage waters. (auth)

22773 KAK DOBYLI SOVETSKII RADII. (How Soviet Radium Is Mined). Pogodin, S. A.; Libman, E. P. Moscow; Atomizdat (1971). 232p.

After a brief summary of the history of radioactivity (Roentgen and Curie), an account is given of the early discoveries of U and Ra in Russia, with emphasis on the Russian scientists and workers who laid the foundations for a Ra industry. One chapter is devoted to a recounting of the events leading up to the production of the first milligram of Soviet radium. The present status of the Ra industry in Soviet Russia is summarized, with allusion to governmental controls in effect. Rare metal by-products of the Ra industry are discussed. 410 references. (K.S.W.)

22774 FURTHER EVIDENCE OF URANIUM MINERALISATION IN ORKNEY. Michie, U. McL. (Inst. of Geological Sciences, London). Inst. Mining Met., Trans./Sect. B; 81: No. 783, 53-4(Feb 1972).

A brief report is presented on the reconnaissance for U in Scotland by the UK Institute of Geological Sciences, with emphasis on the Orkney Islands. (UK)

22775 PARAGENESIS AND ISOTOPIC COMPOSITION OF SOME GANGUE MINERALS FROM THE URANIUM DEPOSITS OF ELDORADO, SASKATCHEWAN. Sassano, G. P.; Fritz, P.; Morton, R. D. (Univ. of Alberta, Edmonton). Can. J. Earth Sci.; 9: No. 2, 141-57(Feb 1972).

A paragenetic sequence of the common mineral constituents of the uraniferous vein deposits of the Fay Mine and Bolger open pit of Eldorado Nuclear Ltd., in northwestern Saskatchewan, is presented. Pitchblende associated with hematite, pyrite, chalcopyrite, bornite, galena, and clausthalite in quartz ± calcite ± dolomite gangues is found in veins cutting folded Tazin metamorphics, adjacent to the St. Louis Fault. Fluid inclusion studies reveal a cooling sequence from the initial phase of mineralization at 440 ± 30°C down to the final stages at around 80 ± 10°C. Stable isotope studies, augmented by petrographic data, serve to distinguish at least five generations of carbonate in the ore veins. Early generations of dolomite have apparently not undergone any significant recrystallization or isotopic readjustment and exhibit original restricted $\delta\ ^{18}O$ (SMOW) values of 9.5 to 11.0% and $\delta\ ^{13}C$ (PDB) values of −0.60 to 0.55%. Isotopic evolution via equilibration with wall rocks has resulted in the deposition of late-stage calcites characterized by $\delta\ ^{18}O$ (SMOW) values of +13.2 to +14.5% and $\delta\ ^{13}C$ (PDB) values of −15.9 to −16.8%. The strong decrease in $\delta\ ^{13}C$ may possibly be explained by a decrease in the amount of CH_4 present in the system. It is felt that the deposits were generated by metamorphic hydrothermal fluids with initial $\delta\ ^{18}O$ (SMOW) values of +6 to +8%, which during cooling underwent isotopic exchange with the host metamorphic rocks and became depleted in ^{18}O. The final stages of mineralization were possibly effected by some influx of isotopically lighter surface waters into an otherwise essentially "closed" system. Present day waters from the Fay Mine have $\delta\ ^{18}O$ (SMOW) values of −16.0 to −16.2% and could represent products of a continuing evolution of the hydrothermal fluids. (auth)

22776 USE OF URANIUM MILL TAILINGS FOR CONSTRUCTION PURPOSES. HEARINGS BEFORE THE SUBCOMMITTEE ON RAW MATERIALS OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, OCTOBER 28 AND 29, 1971. Washington, D. C.; Joint Committee on Atomic Energy (1971). 523p. GPO $2.25.

Verbatim statements made at the Oct. 28 and 29, 1971 hearings before the subcommittee on raw materials of the Joint Committee on Atomic Energy of the US Congress on the use of uranium mill tailings for construction purposes are presented. Additional pertinent information in the form of correspondence, press releases, and technical data on the subject are included. (L.C.L.)

Radioactive Effluents

Refer also to abstracts 22795, 22805, 22816, 24812, 24902–24903, and 24912.

22777 (TID-25894) RADIONUCLIDES IN TRANSPORT IN THE COLUMBIA RIVER FROM PASCO TO VANCOUVER, WASHINGTON. Haushild, W. L.; Stevens, H. H. Jr.; Dempster, G. R. Jr. (Geological Survey, Portland, Oreg. Water Resources Div.); Nelson, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1971. 77p. Dep. NTIS.

The radionuclide discharges in the cooling-water effluent of the reactors on the U. S. Atomic Energy Reservation at Hanford, Wash., were formed by neutron activation of: (1) impurities in the Columbia River water used to cool the reactors, (2) corrosion products from the reactor components, and (3) chemicals used in the water-treatment process. Until all the eight reactors that were cooled by once-through flow were shut down, their cooling-water effluents were the main source of dissolved and particulate radionuclides in the Columbia River. Concentrations and discharges of 13 dissolved and particulate radionuclides were observed at Pasco and Vancouver, Wash., for all or parts of the period from January 1964 to September 1966, and at Umatilla, Oreg., from May 1965 to September 1966. A time-series analysis of concentrations and discharges of eight of the 13 particulate and dissolved radionuclides at Pasco and Vancouver showed a progressive decrease in the concentrations and discharges of many radionuclides during the study period. The decrease was mainly attributable to a decrease in the number of operating reactors. The hydrodynamic and sedimentation characteristics of the Columbia River and the chemical characteristics of the radionuclides were found to be important factors affecting the disposition in the Pasco-Vancouver reach of the radionuclides discharged at Pasco. (auth)

Radioactivity Transport and Monitoring

Refer also to abstracts 22733–22734, 22737–22738, and 22817.

22778 (IS-2791) SURVEY OF ENVIRONMENTAL RADIOACTIVITY, JANUARY 1, 1971–DECEMBER 31, 1971. Voss, Milo D. (Ames Lab., Iowa). Feb 1972. Contract W-7405-eng-82. 39p. Dep. NTIS.

The environmental monitoring of gross alpha and beta determinations of air, soil, vegetation, river water, ALRR outfall, bottom sediment, precipitation, well water, and pond samples in the vicinity of the Ames Laboratory Research Reactor (ALRR) is reported. The ALRR reached full power as of 7/12/65. The ALRR had generated 139,460 megawatt hours as of 12/31/70. A total of 30,650 megawatt hours was generated in 1971. The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. It was concluded that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity. (auth)

22779 (UCRL-Trans-10574) DISTRIBUTION OF RADIOACTIVITY IN LAVA FROM THE CAVITY OF A NUCLEAR EXPLOSION. Audidiere, Pierre; Balard, Francois; Dupouy, Jean-Pierre; Van Kote, Francis (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Translated by Margaret Burke (Univ. of California, Lawrence Radiation Lab., Livermore), from report CEA-R-4099. 22p. Dep. NTIS.

A series of experiments aimed at defining the methods of incorporation of active materials into the substrate at the site of a nuclear explosion is reported. From the properties discovered during the studies, it may be inferred that during cavity formation the behavior of the α-emitting elements is different from those emitting $\beta-\gamma$ radiation. The α-emitters distributed evenly in the molten rock, must be incorporated into it relatively easily and simply diffuse into the liquefied lava. They were not present in the white crystalline fragments. The $\beta-\gamma$ emitters whose characteristic distribution was strongly heterogeneous, preferentially accompanied the dark constituents of the minerals (micas). It is believed that they condense at a later period than the heavy elements. They were not found in the crystalline inclusions. (P.C.H.)

22780 MAN AND HIS ENVIRONMENT: AN INTERNATIONAL SURVEY. Meeting of International Union for Conservation of Nature, Milan, Italy, April 1970. Nebbia, Giorgio. Milan; Tamburini Editore s.p.a. (1971). 335p. L. 5,500. (In Italian and English). (CONF-700453).

Environmental conditions in a number of countries throughout the world are surveyed. Several types of pollution are considered including those resulting from use of nuclear energy. (J.R.D.)

22781 RADIOLYSIS OF WATER AS A SOURCE OF FREE OXYGEN IN THE SUBSURFACE HYDROSPHERE. Gutsalo, L. K. (Inst. of Geology and Geochemistry, Lvov). Geokhimiya; No. 12, 1473-81(Dec 1971). (In Russian).

The existence of free oxygen in subsurface chlorine-calcium brines at great depths (2000 to 3000 m) under reducing conditions of the interior parts, near oil and gas occurrences, in amounts substantially exceeding the possibilities of its dissolution (trapping) from the atmosphere is evidenced for the first time on factual material of the Dnieper–Donets depression. An attempt

is made to explain the origin of free oxygen in underground waters by the radiolysis of water. (auth)

Atmosphere

22782 (COO–1407-39) RAIN SCAVENGING STUDIES. Progress Report No. 8. Dingle, A. Nelson (Michigan Univ., Ann Arbor. Dept. of Meteorology and Oceanography). Jan 1972. Contract AT(11-1)-1407. 103p. Dep. NTIS.

Activities in an empirical study of field data are described. Information is included on deposition patterns and methods of extracting quantitative information. Efforts devoted to theoretical modeling are summarized. A review of entrainment and numerical experiments involving cumulus clouds is included along with work on models of vertical distribution containment and on cloud and rain formation. (J.R.D.)

22783 (HASL–250) GLOBAL INVENTORY AND DISTRIBUTION OF ^{238}Pu FROM SNAP-9A. Hardy, Edward P. Jr.; Krey, Philip W.; Volchok, Herbert L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Mar 1972. 32p. Dep. NTIS.

Following the burn-up of a SNAP generator containing ^{238}Pu in the upper atmosphere of the Southern Hemisphere in April 1964, balloon and aircraft sampling successfully documented the atmospheric transport and inventory of the debris from this unexpected release. Attempts to measure the fallout rate on a continuous basis at sites in both the Northern and Southern Hemispheres were not successful. By the end of 1970, results of the stratospheric measurements indicated that 95% of the SNAP plutonium had deposited over the earth's surface. Integrated fallout in the form of soil samples collected at over 60 sites throughout the world provided the data required to assess the distribution pattern and inventory of the deposited SNAP debris. Of the 17 kilocuries of ^{238}Pu originally in the generator, 13.4 ± 2.2 kilocuries are globally deposited with 3.1 ± 0.8 kilocuries in the Northern Hemisphere and 10.3 ± 2.1 kilocuries in the Southern Hemisphere. This accounts for essentially all of the ^{238}Pu inadvertently released as a result of the satellite abort. (auth)

22784 (UCRL–73182(Rev.1)) SOCIOECONOMIC IMPACT OF LOW-LEVEL TRITIUM RELEASES TO THE ENVIRONMENT. Cohen, Jerry J.; Higgins, Gary H. (California Univ., Livermore. Lawrence Livermore Lab.). 11 Feb 1972. 19p. (CONF-710809–15). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

In accordance with current guidance, tritium releases must be kept below quantities where MPC levels are exceeded, and should be kept as low as practicable. Determination of practicability requires an analysis of benefit versus risk considerations. Such an analysis has been performed for certain general cases. The analysis is based on a mer value of $250 (a "mer" is the amount of benefit required to justify a radiation exposure of one man-rem) and in it the nature of tritium distribution in the biosphere as well as certain demographic factors are considered. Constraints imposed by exposure guides are observed. Results of the analysis indicate that sums greater than ~$0.10/Ci spent for the control of low-level tritium releases might be considered more than would be justified by the environmental risk. The assumptions and calculations are reviewed in detail. The possible social and moral implications of such an analysis are also discussed. (auth)

22785 AIR-BORNE RADIOACTIVITY AT SINDRI. Srivastava, S. C.; Khalsa, S. P.; Das, S. K.; Banerji, K. C. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri); 7: No. 4, 334-6(Oct-Dec 1970).

Results of environmental radioactivity assessment using samples of atmospheric particles collected on filter papers are presented. Data are included on gross beta activity in air, concentration of long-lived particles and general gamma background, and on radon and thoron concentration. The data were collected during the period April through October 1970. (J.R.D.)

22786 GAMMA EMITTERS IN EUPHAUSIIDS FROM THE SOUTHEAST PACIFIC OCEAN. Antezana, T. J. (Univ. of Chile, Vina del Mar); Fowler, S. W. Health Phys.; 22: No. 2, 201-5(Feb 1972).

Specimens of Euphausia mucronata were collected 5 months before and at monthly intervals after the 1966 French nuclear tests until 6th January 1967. Sampling was taken 12 to 25 km off the coast of Chile near Valparaiso (33°00'S lat., 72°00'W long.). Beside the natural ^{40}K, the only radionuclide determined in significant amounts was ^{65}Zn. It is suggested that the fact that animals collected after the September-October tests did not contain any measurable fallout γ emitters was the result of uneven distribution of fallout. Measurements of gross β activity in air samples collected on the coast at Valparaiso are tabulated and discussed in relation to rainfall. The results of the ^{65}Zn studies are tabulated. No ^{65}Zn was determined in samples collected after July 26th and it is suggested that the results are related to ocean currents, diminishing fallout, euphausiid vertical migration, and moulting of exoskeletons. (UK)

22787 DATA, SECTION III, AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 12, 634-42(Dec 1971).

Aug. 1971 measurements of the gross beta activity in surface air and atmospheric precipitation at 73 stations in the U.S. and 24 stations in Canada, and in surface air only at 12 stations in South America are presented. Monthly fallout deposition rates for ^{90}Sr were determined at 65 locations in the western hemisphere and are tabulated. (L.C.L.)

22788 LAST-COLLISION MODEL OF THE AIR-GROUND INTERFACE EFFECT ON FAST-NEUTRON ANGLE DISTRIBUTIONS. French, R. L.; Mooney, L. G. (Radiation Research Associates, Inc., Fort Worth, Tex.). Nucl. Sci. Eng.; 47: No. 3, 375-80(Mar 1972).

The "last-collision" method for computing the air-ground interface effect on scattered neutron intensity is extended to give the effect on the intensity within individual polar angle groups at a detector near the ground. The method yields angle-dependent perturbation factors which can be used to adjust infinite-air angle distributions to account for the presence of an air-ground interface, or to adjust angle distributions from one detector height to another. To determine the factors, a uniform scattering distribution in the air about the detector is assumed, and the fractional contribution from each last-collision center in the air is calculated. In addition, the fraction scattered directly to the detector from the ground surface is calculated using a simplified albedo model. An evaluation of the angle-dependent last-collision model indicated that the results of discrete ordinate calculations for infinite air could be modified to give relative polar angle distributions of the scattered neutron dose near the air-ground interface within 10 to 20% of those calculated directly for the air-over-ground case by the discrete ordinate method. (auth)

22789 RELATIVE ENVIRONMENTAL HAZARD OF FISSION PRODUCTS RELEASED FROM DEFECTIVE FUEL RODS. Eckart, Leroy Edgar. Cincinnati; Univ. of Cincinnati (1971). 142p. University Microfilms Order No. 72-1454.

Thesis.

A method has been developed to assess the relative environmental concern of radionuclides released from holes in the cladding of defective fuel rods. A dimensionless group was formed, composed of variables which appear to be of prime importance in characterizing the long time, small release of radionuclides to the environment. This group is called the Radiological Environmental Concern Index, RECI. The RECI provides a means of ranking radionuclides from reactors in order of concern to the environment. The RECI is defined as: $RECI = C_0(P/B)(T(1/2)/t)$, where a higher value indicates a greater potential concern. The variables are a concentration factor, C_0, production term, P, biological factor, B, radiological half life $T(1/2)$ and a transport time factor, t. Values obtained for the RECI were normalized to 1.0 for strontium-90 (highest value). The lowest RECI value for the radionuclides evaluated was for arsenic-76 with a value of 4×10^{-17}. The research effort centered on the development of the transport time factor, the time required for a radionuclide to flow through a defect in the cladding. Results of preliminary analysis indicated that viscous flow was the dominant release mechanism for fission product radionuclides to be transported through a cladding defect to the primary coolant. A transport time model was developed with the flow mechanism represented by a time-dependent form of the Navier–Stokes equation. A closed form solution of the Navier–Stokes equation was obtained for use with any time-dependent pressure buildup function, representing the internal fission product pressure buildup in the fuel rod. A time dependent pressure buildup function was developed to represent the fission product pressure buildup. A range of hole sizes for the model was determined by analysis of the activity release to the primary coolant of operating reactors. Hole sizes below 10^{-4} cm radius appear to be too small to account for measured activity levels in the coolant. Above 0.010 cm. radius, the hole permits escape of all the fission product radionuclides. A good correlation of experimental and analytical results for activity levels in primary coolant was obtained with hole sizes of 0.001 cm radius. Empirical values of the diffusion coefficient D for use in the pressure function were also obtained by utilizing the time dependent transport equation and measured

activity levels in the primary coolant. These values of D agree within an order of magnitude with values of D obtained from materials research work. The transport time model and solution of the Navier-Stokes equation can be used to predict activity levels in the primary coolant of operating reactors. (Diss. Abstr. Int., B)

22790 RAPID WORKING LEVEL MONITORING. Rolle, R. (Chamber of Mines Research Organization, Marshalltown, S. Afr.). Health Phys.; 22: No. 3, 233-8(Mar 1972).

Aspects of efficient working level monitoring are considered in recommending procedures and instrumentation for different specifications for the total monitoring error. A flexible procedure of high sensitivity requiring only a single gross-alpha measurement and based on completely general limits of radon-daughter ratios in air is presented. It is suggested that optimization of the single gross-alpha measurement procedure to minimize the total monitoring error in this fashion leads to methods which could supplant both existing single measurement methods and those multiple measurement methods in which the overall error exceeds 25% of the Working Level. (auth) (UK)

Soil

22791 ^{90}Sr CONTENT IN THE SOIL OF CENTRAL AND WESTERN REGIONS OF RUSSIA. Ivanov, S. N.; Shagalova, E. D.; Shifrina, S. S. (Belorussian Research Inst. of Soil Behavior, Minsk). Dokl. Akad. Nauk BSSR; 15: No. 7, 641-4(Jul 1971). (In Russian).

The distribution of ^{90}Sr in the soil cover of the central and western parts of Belorussia was investigated as a function of the geomorphological structure of the territory. The influence of the landscape and its associated water run-off on the redistribution of ^{90}Sr is demonstrated in the system: hills-plains-valleys. A rudimentary ^{90}Sr distribution map of the country is included. (tr-auth)

22792 FLUID FLOW THROUGH ROCK SALT UNDER VARIOUS STRESS STATES. Lai, Chia-shing. East Lansing, Mich.; Michigan State Univ. (1971). 142p. University Microfilms Order No. 71-31,248.

Thesis.

Concern for leakage of reactor fuel waste materials from underground salt cavities has prompted questions regarding the permeability of rock salt materials. To provide information on this question, the flow rate of kerosene through rock salt specimens was studied for a range of normal and octahedral shear stresses. Kerosene was used as the fluid because of similarity to radioactive waste materials and its nonrusting properties when in contact with steel. Expressions for the permeability of the rock salt were developed in terms of the stress conditions and void ratios of the rock salt material. A high pressure triaxial cell was designed and constructed for permeability tests at various stress states. The cell was designed for application of axial loads separate from lateral pressures. Independent hydraulic systems maintained axial and lateral pressures to about ±5 psi of selected pressures. Fluid flow occurred axially through the sample under a head differential of 125 psi. Rock salt from an underground formation in Louisiana was cut into cylindrical samples 3 inches high by 3 inches in diameter. Strain gages attached to the sides of the sample provided information on tangential and axial strain. Overall axial deformation, obtained by means of a dial gage mounted outside the triaxial cell, provided a check on strain gage values. Kerosene flow through the sample was recorded at given time intervals. The experimental data provided the basis for developing empirical expressions for the rock salt permeability in terms of the mean normal stresses and octahedral shear stresses. Strain measurements were used in incorporating changes in void ratio into the permeability expressions. The flow of kerosene through the rock salt appears to obey approximately the same laws as developed for flow of water through soils. Laboratory permeabilities for the rock salt varied from 0.0036 to 40.6752 milli-darcy for various stress states. Low permeabilities are interpreted to indicate that leakage of radioactive waste materials from underground salt cavities will be small. (Diss. Abstr. Int., B)

Water

22793 (NCG-TR-30) HYDROLOGIC TRANSPORT OF RADIONUCLIDES FROM NUCLEAR CRATERS AND QUARRIES. Kruger, Paul (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Sep 1970. 131p. Dep. NTIS.

Feasibility studies of proposed applications of nuclear explosions for civil construction have shown that the responsible engineering agency must have the capability to predict the safety of the applications. One specific need for nuclear excavation projects is the development of adequate methods for estimating the hydrologic transport of radionuclides from excavation sites. In such models consideration must be given to the complexity of the nuclear, hydrologic, and environmental processes involved. Also, the model must be usable as a tool to predict, with reliability, the concentration of radionuclides in surface waters and groundwaters at locations downstream of a nuclear crater or quarry. A review of the literature related to the development of numerical and experimental methods for predicting the hydrologic transport of radionuclides is presented with specific application to nuclear excavation and quarrying. Several models have been developed for predicting surface water and groundwater dispersion and transport of radionuclides. Because of the complexity of the processes involved, major simplifications are required to describe the transport for computer calculation. Since no large-scale excavation or quarrying experiments involving the interaction of water at the detonation site have been conducted, the prediction models have not been confirmed. The possibility of using radioactive and activable tracer methods for experimental study of hydrologic transport under field conditions to assist in the development of a successful prediction model is examined. (auth)

22794 (RLO-1750-49) RADIONUCLIDE DISTRIBUTION IN COLUMBIA RIVER AND ADJACENT PACIFIC SHELF SEDIMENTS. Forster, William O. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. Contract AT(45-1)-1750. 59p. Dep. NTIS.

Studies were made to elucidate the complex pathways the radionuclides from Hanford's nuclear reactors take as they move downstream, continually mixing with the water and being sorbed on biota and sediments. The dynamic relationships between the radionuclides and their environment are discussed relative to the effects of streambed and suspended sediment particle size on total activity of sediment samples from Hood River to the Estuary and off the shelf, within 100 miles of the mouth; various types of bonding between the radionuclides and the sediment surfaces in river samples; resulting changes in individual activities of specific radionuclides in sediments due to extreme flood and reducing conditions in the estuary; tracer aspect of using paired radionuclides of different decay constants to determine transport rates of surficial sediments as they move out from the mouth and across the shelf; and relative contribution of natural fission product and neutron-induced radioactivity on coastal shelf sediments at different depths and various distances from the mouth of the Columbia River. A brief illustration of the specific activity approach in sediment analysis is also given. (P.C.H.)

22795 (RLO-1750-60) RADIOACTIVE AND STABLE NUCLIDES IN THE COLUMBIA RIVER AND ADJACENT NORTHEAST PACIFIC OCEAN. Forster, William O. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1969]. 68p. Dep. NTIS.

The integrated results from several individual projects concerning the chemical and physical behavior of several radionuclides in the estuary and plume of the Columbia River are presented. Discussion is included on: background; Columbia River radionuclides; Columbia River Estuary radioactivity and stable concentrations; Columbia River plume radioactivity and stable concentrations; radio and stable nuclides outside the Columbia River plume area; and specific activities of Northeast Pacific water. (P.C.H.)

22796 CONTENT OF ^{90}Sr IN SOME ORGANISMS IN THE BLACK SEA (1965-1968). Parchevskii, V. P.; Sokolova, I. A. (Inst. of Biology of the Southern Oceans, Sevastopol). Dokl. Akad. Nauk SSSR; 199: No. 3, 705-7(21 Jul 1971). (In Russian).

It had previously been shown that during 1961 through 1965 Black Sea organisms exhibited an increase in ^{90}Sr content. This four-year continuation of the study revealed that in plants and animals of the Black Sea a gradual increase in ^{90}Sr concentration took place during 1965 through 1968, although the rate of increase was noticeably less than that of the previous five years. (K.S.W.)

22797 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 12: No. 12, 631-3(Dec 1971).

Data are presented on the gross alpha and gross alpha-plus-beta radioactivity in Kansas surface waters from January through December 1970. (L.C.L.)

22798 RADON WATERS IN THE CAUCASUS. Kyuregyan, T. N. (Inst. of Geological Science, Erevan). Izv. Akad. Nauk Arm. SSR, Nauki Zemle; 23: No. 4, 92-3(1970). (In Russian).

Mineral carbonated waters of different complex rocks in one region of the Caucasus are characterized by low Rn content. The background concentrations of Rn in such waters depend on the gamma activity in the rock, and seem to be independent of climatological factors, the extent of mineralization, and chemical composition of the waters. (K.S.W.)

22799 STUDY OF RADIOACTIVE ISOTOPE DISTRIBUTION BETWEEN SEAWATERS AND SEDIMENTS. Kuznetsov, Yu. V.; Shchebetkovskii, V. N. Geokhimiya; No. 12, 1466-72(Dec 1971). (In Russian).

The sorption of cesium-137, cerium-144, thorium-234 by red deep-sea clay, iceberg, foraminiferic, and diatomaceous oozes has been investigated during a change of the specific content of sediment in sea water. On the basis of geochemical principles, an explanation of the established sorption series is given, in which the capacity of sediments for cerium-144 and cesium-137 extraction increases. The differences in the character of distribution of the investigated isotopes is shown. (auth)

Ecosystems and Food Cycles

Refer also to abstracts 22816, 22823, 23159, 23174, 23181, 23186, 23189–23191, and 23416.

22800 (NOAA-TM-ERL-ARL-29) STUDIES OF THE TRANSFER OF RADIOIODINE GAS TO AND FROM NATURAL SURFACES. A SUMMARY OF CONTROLLED ENVIRONMENTAL RELEASE TEST ANALYSES (1963–1969). Markee, Earl H, Jr. (National Oceanic and Atmospheric Administration, Silver Spring, Md. Air Resources Labs.). Apr 1971. 28p.

Some significant results of studies of the transfer of radioiodine gas to and from natural grass surfaces at the National Reactor Testing Station in Idaho are presented. These results were obtained from experiments conducted in the field over pastures and in an environmental chamber. Some of the significant findings are: the "resistance approach" yields good agreement with measured values during unstable conditions; sorption of radioiodine gas was found to be proportional to a function of grass surface area and stomatal opening; and the depletion from an effluent cloud of radioiodine gas appears to be independent of transfer velocity to the underlying surface and atmospheric stability. Suggestions for future research are presented. (auth)

22801 (ORO-490-21) RADIOACTIVITY TRANSPORT IN WATER: CONTINUOUS RELEASE OF RADIONUCLIDES IN A SMALL SCALE ECOSYSTEM. Technical Report. Gloyna, Earnest F.; Yousef, Yousef A.; Padden, Thomas J. (Texas Univ., Austin. Dept. of Civil Engineering). 30 Sep 1971. Contract AT(11-1)-490. 78p. (EHE-71-1; CRWR-75). Dep. NTIS.

Model rivers were simulated in two channels of a research flume. The control channel of the model river system contained a typical bottom sediment and received a potable water supply. The second channel, in addition to bottom sediment, contained a lush community of rooted aquatic plants in one end and received water which was rich in phytoplankton. Both channels were subjected to a continuous release of ^{134}Cs and ^{85}Sr for periods up to thirty-five days. The distribution of the radionuclides in the bottom sediment, plants, algae, and water was determined. Under the conditions of the release, less than maximum permissible concentration, the radioactivity continued to increase on the surface of bottom sediments until a quasi-equilibrium level was reached at approximately 25 days after initiation of release. At this condition or saturation, the specific activity of bottom sediments associated with ^{134}Cs and ^{85}Sr approached 55 $\mu\mu$ c/cm^2 and 3.34 $\mu\mu$ c/cm^2 and 3.34 $\mu\mu$ c/cm^2 respectively, and sediment concentration factors were 275 ml/cm^2 and 85 ml/cm^2. In the case of rooted plants, quasiequilibrium for ^{134}Cs (89 $\mu\mu$ c/gm of plant) and for ^{85}Sr (25 $\mu\mu$ c/gm of plant) was reached within two days. The plant weight was based on oven dried mass. Plant concentration factors averaged 400 and 600 ml/g respectively for ^{134}Cs and ^{85}Sr. In the phytoplankton rich water, it was found that as much as 27% of the radioactivity of the water was actually contained on or in the phytoplankton. The rate of ^{134}Cs uptake by the phytoplankton was related to net photosynthetic oxygen production. The experimentally determined parameters were applied to predictive models and these relationships were checked against some observed data. (auth)

22802 (SWRHL-65-r) PRELIMINARY RADIATION SURVEILLANCE OF AN AQUATIC SYSTEM NEAR THE NEVADA TEST SITE, JUNE–JULY 1967. Klein, William L.; Brechbill, Raymond A. (Western Environmental Research Lab., Las Vegas, Nev.). Feb 1972. 27p. Dep. NTIS.

Results of a three-month preliminary radiation surveillance study of an aquatic system in Upper Pahranagat Lake near the Nevada Test Site are presented. The study was conducted to determine the concentrations of fission products in selected samples and to establish the necessary methodology for radiation surveillance in an aquatic ecosystem. Radionuclide concentrations were found to be insignificant in water, aquatic plant, and fish samples. Sediment samples had detectable levels of ^{137}Cs, ^{40}K, ^{90}Sr, and U. Strontium-90 levels in fishbone were low (2.38 pCi/g bone ash) compared with those found in bovine femur samples (6.9 pCi/g bone ash) collected during the same period. (auth)

22803 EFFECT OF COPPER ON ^{90}Sr CONTENT IN TIMOTHY. Shalaeva, T. V.; Sabardina, G. S.; Miller, A. T. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis; No. 7, 23-5(1971). (In Russian).

The application of copper in combination with nitrate, phosphate, and potash fertilizers serves to lower by 49 to 67 percent the penetration of radioactive strontium-90 in the above-ground mass of Phleum pratense. The established property of copper undoubtedly is of great practical importance, as it shows the possibility of lowering the radioactivity in pasture herbage. The aim of further research should be a more profound study of copper action on the accumulation of strontium-90 by other valuable agricultural varieties. It is important also to determine the mechanism of the interaction between copper and strontium-90 in the plant organism. (auth)

22804 ^{90}Sr AND ^{137}Cs IN CANNED SEAFOOD, TAIWAN, REPUBLIC OF CHINA, 1970–1971. Weng, P. S.; Liu, Agnes P. L. (National Tsing Hua Univ., Hsinchu, Taiwan). Radiol. Health Data Rep.; 12: No. 12, 615-16(Dec 1971).

Data are presented from 1970 and 1971 measurements of the ^{137}Cs and ^{90}Sr content and gross beta radioactivity of canned seafood received at Taiwan from Europe, Japan, North America, and Taiwan. It was found that the gross beta activity of canned fish (sardines, mackerels, herrings, salmon, tuna, etc.) was 0.61 of that in fresh fish and that canned deep-sea shellfish (crabs, clams, lobster, etc.) had 0.33 the gross beta activity of the canned fish. (L.C.L.)

22805 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: No. 12, 643-62(Dec 1971).

A summary is presented of environmental radioactivity data for the Hanford Atomic Products Operation. Information for the Hanford Area is included on: source and levels of environmental radioactivity; radioisotopes in reactor effluents; flow and radioisotope content in Columbia River, 1965 to 1969; transport rate for specific radioisotopes in Columbia River, 1965 to 1969; ^{131}I and ^{3}H content in ground water, 1969; ^{131}I content in atmosphere, 1969; radioisotope content in drinking water, 1969; radioisotope content in Columbia River fish during 1969 and the dose rate to humans from eating these fish; radioisotope content in game birds, shellfish, milk, and produce; annual radiation dose from fallout during 1969; and dose estimates for "maximum" and "average" individuals for 1969. This surveillance program indicated that most of the environmental radiation dose for the majority of persons living in the Hanford environs was due to natural sources and worldwide fallout rather than to Hanford operations. During 1969, radiation doses of Hanford origin were less than 0.1 of the appropriate dose standards and reflected a general decrease from comparable 1968 values for most organs. (L.C.L.)

22806 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 12, 617-30(Dec 1971).

The amounts of ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr in milk at milk network monitoring stations in Canada, the U.S., and Central and South America were measured during the period from Sept. 1, 1970 to Sept. 1, 1971. The results for ^{137}Cs, ^{131}I, and ^{90}Sr are tabulated and discussed. The ^{140}Ba and ^{89}Sr levels were below the respective practical reporting levels. Data are also presented from Jan. to June 1971 measurements of the carbon-14 content in the total diet at nine U.S. cities. (L.C.L.)

22807 STUDY OF THE RADIOCONTAMINATION OF THE FOOD CHAIN DURING THE YEARS 1968 AND 1969 AND REPORT ON 6 YEARS OF RESEARCH ON RADIOCONTAMINATION OF FOODS. Cantillon, G. E.; Lafontaine, A. (Institut d'Hygiene et d'Epidemiologie, Brussels). Arch. Belg. Med. Soc., Hyg., Med. Trav. Med. Leg.; 29: No. 2, 81-97(Feb 1971). (In French).

The results of analytical studies on the radiocontamination of the food chain during 1968 and 1969 are given along with discussion on interpretation of the results. For ^{90}Sr the ingested activity

represents 40% of the activity ingested in 1964. For ^{137}Cs the daily ingestion represents no more than 10% of the initial value which results in a decreasing value for the Cs/Sr ratio. The ingested activities have never constituted a danger and remain lower than permissible levels for the population. (tr-auth)

Radiometric Techniques

22808 (IEA-231) DATING OF BRAZILIAN INDIAN POTTERY BY THERMOLUMINESCENT DOSIMETRY. Szmuk, Peter; Watanabe, Shigueo (Instituto de Energia Atomica, Sao Paulo (Brazil)). Feb 1971. 7p. Dep. NTIS (U. S. Sales Only).

The thermoluminescent dosimetry method was used to determine ages of funeral urns found in Itapeva, Piraju, and Angatuba, Sao Paulo State, Brazil. The thermoluminescence (TL) induced by radioactivity in the urn and the surrounding earth where the urns were found, was measured in small quartz crystals contained in the urn, after these were separated magnetically from the clay. From this value of TL the total absorbed dose was determined. The annual β- and γ-dose of the surrounding earth and the urn itself was determined, finding the U, Th and K content by the alpha counting method and chemical method. An annual dose of 240 to 270 mrad was found. At Itapeva, 10 Harshaw TLD-100 encapsulated dosimeters were buried for 132 days to confirm the derived γ-dose of about 106 mrad/year. Dividing the total dose accumulated in the urn by the annual β- plus γ-dose ages of approximately 1070 (±130) years for Itapeva urns, 1020 (±120) years for Piraju samples, and 1210 (±145) years for Angatuba potteries were found. The ^{14}C method applied to human bones contained in the Itapeva urn produced an age of approximately 1000 years. (auth)

22809 GEOMETRIC INVERSION AND ITS USE IN THE X-RAY RADIOMETRIC AND GAMMA–GAMMA METHOD. Leman, E. P.; Ochkur, A. P. Geofiz. App.; No. 43, 98-105(1970). (In Russian).

It is shown analytically that the inversion character of the dependence of intensity of secondary (characteristic or scattered) radiation on variations in the distance between detector and surface of the medium investigated is explained by the effect of the geometric factor, i.e., the ratio of sonde length to that distance. The inversion point falls where the value of that ratio is unity. Aspects of the use of the geometric inversion effect in the x-ray radiometric and gamma–gamma methods in connection with the building of noise-resistant sondes are examined. In particular it is shown that in paired sondes, the limits of compensation for variation of the distance between detector and surface of the medium investigated are governed by the position of the inversion points of the small and of the large sonde. (Geophys. Abstr.)

22810 DATA REPRESENTATION. Proceedings of a Seminar Held at Canberra, Australia, 10 December 1969. Anderssen, R. S.; Osborne, M. R. (eds.). St. Lucia, Australia; University of Queensland Press (1970). 120p. $2.00. (CONF-691231).

Thirteen papers dealing with data representation as a modelling problem cover aspects of the selection, implementation and verification of an appropriate model. One paper is given a separate abstract. (Australia)

For abstract of an individual paper see: 22811.

22811 Rb–Sr GEOCHRONOLOGY: AN APPLICATION OF TWO ERROR REGRESSION ANALYSIS. Compston, W. (Australian National Univ., Canberra). pp 29-33 of Data Representation. /Anderssen, R. S. (ed.). St. Lucia, Australia; Univ. of Queensland Press (1970).

From Seminar on data representation; Canberra, Australia (10 Dec 1969).

Least squares fitting in the presence of $^{87}Sr/^{86}Sr$ and $^{87}Rb/^{86}Sr$ errors is described and models are proposed for particular geological errors prior to the fitting of regression lines. (Australia)

22812 NEUTRON METHOD FOR DETERMINING RESIDUAL OIL-PHASE FLUID CONCENTRATION. Jorden, James R. Jr.; Mitchell, Forrest R. (to Shell Oil Co.). U. S. Patent 3,631,245. 28 Dec 1971. Filed 23 Dec 1968.

A method is described for determining the concentration of oil-phase fluid in an earth formation containing indigenous oil-phase fluid and aqueous liquid. A zone in the formation is irradiated with neutrons when the zone is filled with indigenous oil-phase and aqueous liquid. The thermal neutron capture rate response of the zone is measured with respect to the first irradiation. Substantially all indigenous oil-phase is removed from the zone and the zone is filled with only an aqueous liquid substantially equivalent in composition to the indigenous aqueous liquid. The zone is irradiated with neutrons a second time and the thermal neutron capture rate response of the zone is measured with respect to the second irradiation. (Official Gazette)

22813 EXTINCT RADIOACTIVE NUCLIDES AND PRODUCTION OF XENON ISOTOPES IN NATURAL GAS. Boulos, M. S.; Manuel, O. K. (Univ. of Missouri, Rolla). Nature (London) Phys. Sci.; 235: No. 60, 150-2(21 Feb 1972).

The occurrence of radiogenic ^{4}He and ^{40}Ar in natural gas wells has promoted studies of Xe in these gases. In order to obtain reliable isotopic data with which to examine mechanisms for the production of Xe isotopic patterns in natural gases large volumes of gas from a number of deep wells were analyzed and results are shown in tabular form. Great care was taken in sampling and analyzing these gases to prevent atmospheric contamination or any fractination. The Xe in all the wells showed enrichment in ^{129}Xe, the decay product of ^{129}I. In order to obtain reliable information on the Xe component arising from nuclear decay it is essential to identify isotopic anomalies resulting from fractination effects in the trapped Xe component and in this connection the isotopic ratios obtained from the analysis show isotopic correlations suggestive of mass dependent fractination. The Xe from all wells showed an enrichment of the heavy isotopes which appears to be between the fission yields of ^{238}U and ^{244}Pu. Since all the gas samples showed enrichment of ^{129}Xe from the decay of now extinct ^{129}I it might be expected that the heavy Xe isotopes contain a component of fission products from extinct ^{244}Pu. It is concluded that most natural gases contain at least small enrichments of ^{129}Xe from the decay of extinct ^{129}I. Some of these gases also show enrichment in the heavier isotopes $^{131-136}Xe$, apparently a mixture of fission products from ^{238}U and ^{244}Pu. (UK)

22814 CHRONOLOGICAL TEST OF OCEAN-BOTTOM SPREADING IN THE NORTH ATLANTIC. Fleischer, R. L. (General Electric Co., Schenectady, N. Y.); Viertl, J. R. M.; Price, P. B.; Aumento, F. Radiat. Eff.; 11: No. 3-4, 193-4 (Dec 1971).

Fission-track and K-Ar dating of basaltic glass from the Mid-Atlantic Ridge gives results which are consistent with the proposal of ocean-floor spreading. Correlation exists between the magnetic anomaly patterns over the Crest Mountains at 45°N and the age of the outcropping basalts. The observed sequences of ages progressing outward from the Median Valley, 11,000, 230,000, 310,000, 750,000, 8,000,000, and 16,000,000 years, constitute strong, direct support for the idea of ocean-bottom spreading. (auth)

22815 OXYGEN ISOTOPE PROFILES THROUGH THE ANTARCTIC AND GREENLAND ICE SHEETS. Johnsen, S. J. (Univ. of Copenhagen); Dansgaard, W.; Clausen, H. B.; Langway, C. C. Jr. Nature (London); 235: No. 5339, 429-34(25 Feb 1972).

The Camp Century, Greenland, deep ice core reveals seasonal variations in the isotopic composition of the ice back to 8,300 years BP. This is not the case for the Byrd Station, Antarctica, deep ice core. Both cores show long-term perturbations in isotopic composition reflecting climatic changes from before the beginning of the last glaciation. But the complexity of the glaciological regime at Byrd Station precludes a rational choice of a time scale. Pole-to-pole correlations of the palaeoclimatic data therefore become speculative except for the more pronounced features and general trends. (auth)

Site Surveys

Refer also to abstracts 24744 and 24938.

22816 (CEA-CONF-1876) STUDY OF A MARITIME SITE WITH THE VIEW OF DISPOSAL OF RADIOACTIVE WASTE. Avargues, M. (Commissariat a l'Energie Atomique, [Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). [nd]. 6p. (In French). Dep. NTIS (U. S. Sales Only).

The construction of a plant for the processing of irradiated fuel elements on the Cape of La Hague necessitated a detailed study of the effects of the release of low radioactive wastes to the sea. In addition to technical, economic, and social evaluations, hydrographic studies were made. These included theoretical tests with a rotating model made in conjunction with on-site experiments. Rhodamine B was used to confirm the existence of a current toward the northeast. The results obtained with the dye permitted the establishment of the different tidal coefficients under different meteorological conditions and of the dispersion gradients. A systematic study was made of the natural and artificial radioactivity of the marine organisms, animals, and vegetables. For ^{137}Cs the accumulation was principally in the flesh of certain species such as shrimp and blennie. The alga Corallina officinalis and the ascidium Dendrodoa grossularia accumulate the ^{106}Ru the

most. The alga Corallina officinalis is remarkable by its high concentration factor for ^{144}Ce. The alga Chondrus crispus has a higher degree of accumulation of ^{106}Ru and ^{144}Ce than the mollusks and crustaceans. (J.S.R.)

22817 (IDO–12075) 1970 ANNUAL REPORT OF THE HEALTH SERVICES LABORATORY. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.). [1971]. 51p. Dep. NTIS.

The Health Services Laboratory (HSL) is composed of five branches: Analytical Chemistry, Dosimetry, Environmental, Instrumentation, and Medical. Additionally, the U.S. Geological Survey (USGS) and the Air Resources Laboratories Field Research Office of the National Oceanic and Atmospheric Administration (NOAA) maintain technical staffs at the National Reactor Testing Station for which the HSL provides programmatic direction for their NRTS activities. The first responsibility of the Laboratory is to the NRTS, supplying services to the contractors in various fields including industrial medicine, personnel dosimetry, portable instrumentation, chemical and radiochemical analyses, as well as providing all environmental monitoring on and off the NRTS for air, water, soils, vegetation, and other selected types of samples such as milk and food grains.While a large share of the Laboratory's efforts is devoted to the routine work, considerable research and development work is performed, not only for the NRTS, but also for the AEC's Divisions of Biology and Medicine and of Reactor Development and Technology, both of which fund a portion of our efforts. A considerable part of the Laboratory's time and efforts is presently devoted to the AEC's Regulatory Program, providing environmental and chemical services to the Division of Compliance in its efforts to determine independently the conditions within, and in the environment of, various licensed facilities around the country. These have included boiling- and pressurized-water power reactors, fuel fabricating facilities, uranium mills, and materials handling facilities. The more important aspects of HSL activities during 1970 are reviewed. (L.C.L.)

22818 EKSPERIMENTAL'NAYA SEISMOLOGIYA (SBORNIK STATEI). (Experimental Seismology (Collection of Reports)). Sadovskii, M. A. (ed.). Moscow; Izdatel'stvo Nauka (1971). 424p.

This collection of 40 reports was presented at a meeting of the Complex Seismological Expedition in 1967. Descriptions are given of new apparatus development. The origin, propagation, and nature of seismic waves on the earth's surface are explored. The spectral nature of the recorded phenomena, the seismic studies made of the earth's crust and upper mantle, and special problems encountered in Central Asia are topics of a number of papers. The predictability of earthquakes and geophysical phenomena which precede earthquakes also receive treatment. (K.S.W.)

Thermal Effluents

Refer also to abstracts 22720, 24812, 24814, 24869, 24879, 24902 – 24903, 24906, and 24912.

22819 (CONF-711130–, pp 562-9) DISPERSAL OF HEAT FROM POWER STATIONS. Fryer, J. J.; Howard, K. A. (State Electricity Commission of Victoria (Australia)). 1971.

From fourth Australiasian conference on hydraulics and fluid mechanics; Melbourne, Australia (29 Nov 1971).

The conversion of thermal energy into electrical energy at power stations necessitates considerable quantities of low-grade heat being dissipated into the atmosphere from the stations' cooling water systems. The demand for electrical energy is doubling approximately every decade and available water resources must be utilized to dispose this increasing heat load. Methods available include simple single pass systems in which the available water is used only once, and more elaborate systems employing cooling towers, cooling ponds or marine estuaries and bays. These systems involve an understanding of the heat transfer processes and its effects on the environment which can become highly complex in tidal estuaries. Field studies, together with mathematical and/or hydraulic models, can assist in determining the physical features of a proposed system, while biological studies can indicate the probable effect on aquatic life. Some examples of these aspects in Victoria are described. (auth) (Australia)

22820 (HEDL-TME–71-192) ENVIRONMENTAL ENGINEERING PROGRAMS. Quarterly Technical Progress Report, October–December 1971. Bailey, G. F. (comp.) (Hanford Engineering Development Lab., Richland, Wash.). Contract AT(45-1)-2170. 27p. Dep. NTIS.

Progress is reported in programs on simulation modeling of environmental effects of thermal generation, regional modeling of surface water temperature from projected power growth, and evaluation of environmental aspects involved in nuclear plant site selection. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 22763.

General Detectors and Monitors

Refer also to abstracts 22906 and 22907.

22821 (AD–731350) PULSE REACTOR RADIATION DETECTION SYSTEM USING AN ON-LINE COMPUTER. Leonard, B. E.; Pfeiffer, W. E.; Hughes, D. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jul 1971. 29p. (AFRRI-TN–71-3). NTIS.

A pulse reactor radiation detection system is described. The system uses an on-line Scientific Data Systems (SDS) 920 computer, coupled through an analog-to-digital converting interface, to record and retain the response data for various radiation detectors. Results of typical measurements are presented. An overall range of sensitivity of one million is possible with a precision to within about 5% (exclusive of the detectors) for determining relative reactor power, neutron and gamma-ray flux densities (if the spectra remain constant), and neutron and gamma-ray tissue kerma rates or the time integral of these quantities. This range is achieved by using combinations of radiation sensors. (auth) (GRA)

22822 (ARH–2247) ZERO DISPLACEMENT, LIQUID NITROGEN LEVEL MONITOR FOR SEMICONDUCTOR DETECTORS. Zimmer, William H. (Atlantic Richfield Hanford Co., Richland, Wash.). Jan 1972. Contract AT(45-1)-2130. 19p. Dep. NTIS.

Lithium-drifted germanium [Ge(Li)] and lithium-drifted silicon [Si(Li)] detectors are operated at liquid nitrogen temperatures. If the detector is warmed while the bias voltage is applied, the detector is destroyed. Proper use of a strain gage to monitor the liquid nitrogen in semiconductor detector assemblages constitutes the least expensive system that does not induce statistically significant detector–sample displacement, monitors continuously, reads directly and linearly in units of liquid nitrogen volume or weight, provides a signal which can trigger an alarm, does not use liquid nitrogen to operate, and is fail-safe. Any measurement system component failure will cause an alarm. (6 figures) (auth)

22823 (BFL-1/1971) PORTABLE BETA–GAMMA SPECTROMETER. Frank, Alfred (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe (West Germany). Institut fuer Strahlentechnologie). Apr 1971. 144p. (In German).

The construction and circuits of a portable 6-channel spectrometer which has its own power supply are described. Both a detector for gamma radiation and a detector for beta radiation for the surveillance of the degree of contamination of foodstuffs are connected. The instrument is adapted for the measurement of the most important radionuclides of fallout (^{131}I, ^{137}Cs, ^{140}Ba, ^{140}La, ^{89}Sr, and ^{90}Sr). (57 figures, 6 tables, parts list) (auth)

22824 (CERN-Trans–71) SOME SCINTILLATION PROPERTIES OF UNACTIVATED CsI AT ROOM TEMPERATURE. Langkau, R. Translated by J. Nicholls (European Organization for Nuclear Research, Geneva, Switzerland), from Z. Naturforsch.; 21a: 470-4(1966). 11p. Dep. NTIS (U. S. Sales Only).

The scintillation behavior as a function of time of an unactivated CsI crystal at room temperature was investigated by means of a sampling storage process. Alpha particles and γ quanta were used to produce scintillation. The process is composed of a fast and a slow component, the intensity ratio of the two components depending to a very considerable extent on the type of the exciting radiation. This fact may be used to discriminate between particles. (For abstract from original language see NSA 20: 35791). (auth)

22825 (CERN-Trans–71-38) RESEARCH INTO THE SCINTILLATION BEHAVIOUR OF A FEW FAST ORGANIC PLASTIC AND FLUID SCINTILLATORS. Kunze, R.; Langkau, R. Translated by J. Nicholls (European Organization for Nuclear Research, Geneva, Switzerland), from Nucl. Instrum. Methods; 91: 667-8 (1971). 6p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 25: 18656. (R.W.R.)

22826 (JINR–P13-6103) Ge(Li) DETECTOR CRYOSTAT WITH THE MOBILE VACUUM ISOLATION OF SORBENT. Vasilieva, E. V.; Voronov, B. I.; Govorov, A. M. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Neutron Physics). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

A cryostat for a Ge(Li) detector and the main results of the experimental test of the basic cryostat parameters are described. The parameters under discussion include the following: the rate of establishing thermal equilibrium and the temperature difference between the cooling agent and the detector end of the cold finger; the rate of pumpdown for both the detector chamber and the whole cryostat; and the air sorption isotherms for the adsorbent mixture at liquid nitrogen temperature. It was found that a vacuum of (2 to 3) $\times 10^{-7}$ to 1×10^{-5} torr can be maintained during the course of, at least, a decade in such a cryostat, if leakage is 5×10^{-5} cm^3/h. (4 figures) (auth)

22827 (LA–4886) EFFICIENCY OF XENON IONIZATION CHAMBERS FROM 10 TO 80 keV. Lyons, Peter B. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 8p. Dep. NTIS.

The efficiency of a xenon ionization chamber for x rays in the 10 to 80 keV energy range is discussed. A chamber with gas pathlength of 33.7 cm with a fill pressure of 48 psia is considered. Theoretical calculations are presented of the major energy loss mechanisms for such a chamber. Chamber efficiencies exceeding 92% are obtained below 35 keV. In the 35 to 80 keV range, efficiencies are between 60 and 80%. (3 figures, 2 tables) (auth)

22828 (SZS–14/71 (pp 1-14) QUANTITATIVE ALPHA AUTORADIOGRAPHY WITH STRIPPING FILMS. Friemert, R.; Kraus, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

The properties of the stripping films ORWO K 102, K 105, and K 106 and Kodak AR 10 were investigated with regard to their applicability in quantitative alpha autoradiography. The films were tested with respect to reproducibility, sensitivity, fading, and linearity of the dependence of the film response on the flux. Evaluation was performed by density measurements — in the case of ORWO K 102 and Kodak AR 10 by density measurement and track counting for different flux ranges. Finally, for track counting the possibility of eliminating experimental film calibration by standard sources is discussed. (auth)

22829 OPTICAL PHOTON PRODUCTION IN ANTHRACENE BY ELECTRONS WITH ENERGIES BETWEEN 2 AND 10,000 eV. Fisher, T. R.; Kohler, D. (Lockheed Palo Alto Research Lab., Calif.). Rev. Sci. Instrum.; 43: No. 3, 471-5(Mar 1972).

The response of an anthracene scintillation detector to electrons with energies from 2 to 10,000 eV is reported. The detector response, instead of falling rapidly to zero at energies less than 1000 eV, approaches a constant value of 0.56 photon/incident electron at low energies. The response of the detector in this very low energy region apparently results from a new photon production mechanism which is not understood at present. Above 1000 eV, significantly better spectra are obtained than have been reported previously. (auth)

22830 AMPLIFIER FOR ELECTRON MULTIPLIER PULSE COUNTING APPLICATIONS. Smith, J. B. (Univ. of Texas, Dallas). Rev. Sci. Instrum.; 43: No. 3, 488-92(Mar 1972).

An amplifier designed for use in a soft particle spectrometer on the ISIS series of scientific satellites is described. The amplifier design reflects the satellite constraints of low power (~90 mW), low weight (120 g), and small size (~10 × 3 × 2.5 cm). It uses a voltage sensitive front end which accepts multiplier pulses ranging from about 0.5 to 50 mV and produces output pulses of uniform amplitude and duration suitable for driving a counter. Dynamic limiting is used to produce a variable gain depending on the amplitude of the input pulse. This allows maximum gain for small pulses, avoids heavy saturation by large pulses and minimizes recovery time. The amplifier has full sensitivity for input pulse rates up to 20 MHz for a uniform test signal. (auth)

22831 CALCULATED EFFICIENCY VALUES FOR WELL-TYPE NaI(Tl) DETECTORS. Holmberg, P.; Rieppo, R.; Passi, P. (Univ. of Oulu, Finland). Int. J. Appl. Radiat. Isotop.; 23: No. 3, 115-20(Mar 1972).

Gamma-ray efficiency values for well-type NaI(Tl)-detectors in the gamma-ray energy range of 0.1 to 10 MeV were calculated for 2 in. × 2 in., 3 in. × 3 in. and 4 in. × 4 in. detectors with the following well dimensions: depth 39 mm and well dia. 16 mm, 20 mm, and 25 mm. Values for a 1¾ in. × 2 in. detector (well depth 39 mm, well dia. 16 mm) are also included. Efficiency values for a needle-shaped source are given. (auth) (UK)

22832 SEMICONDUCTOR DETECTORS FOR ELECTRONS. (to Siemens Aktiengesellschaft). British Patent 1,266,431. 8 Mar 1972. Priority date 30 May 1968, Switzerland.

A silicon detector with a thin aluminum window is described for detection of low-energy electrons (<100 keV). (W.H.K.)

22833 FORMATION OF CHARGED PARTICLE TRACKS IN INSULATING MATERIALS. Khan, H. A. (Univ. of Birmingham, Eng.). Nucleus (Karachi); 8: No. 3, 29-36(Jul-Sep 1971).

During the last decade, a considerable amount of work has been done in understanding the basic mechanism of track formation in insulators. Various existing theories of track formation are reviewed and discussed in the light of experimental data. (auth)

22834 ANALYTICAL DERIVATION OF THE GEOMETRIC FACTOR OF A PARTICLE DETECTOR HAVING CIRCULAR OR RECTANGULAR GEOMETRY. Thomas, G. R.; Willis, D. M. (Radio and Space Research Station, Slough, Eng.). J. Phys., E (London); 5: No. 3, 260-3(Mar 1972).

Both isotropic and "$\cos^2\theta$" variations of intensity are considered. An approach based on "shadow areas" is applied to the case of particles passing through two unequal circular areas, and it is proved that the results are identical with those obtained previously using an approach based on the direct integration of "infinitesimal areas". This latter approach is then used for the case of two unequal rectangular areas, which has not been considered previously. The analytical results confirm those obtained previously using numerical techniques. (auth) (UK)

22835 POLARIZATION STUDIES USING THE NEUTRON SPIN-PRECESSION METHOD WITH A CONTINUOUS ENERGY SPECTRUM OF NEUTRONS. Nath, R.; Firk, F. W. K.; Holt, R. J.; Schultz, H. L. (Yale Univ., New Haven). Nucl. Instrum. Methods; 98: No. 3, 385-91(1972).

Precise measurements of the polarization of neutrons in the MeV region have frequently made use of the spin-precession method. These measurements have been carried out with nearly monoenergetic neutron sources. A development of the method that makes it suitable for the more general class of experiments involving a continuous energy spectrum of neutrons is presented. For a fixed value of the solenoidal field, the angles of precession for neutrons of all energies are determined using a high resolution time-of-flight spectrometer. The power of the technique is demonstrated by measuring the polarization of photoneutrons from the reaction $^{16}O(\gamma,\vec{n})^{15}O$ at an angle of 45°. The neutron energy range covered in a single experiment is from 5 to 15 MeV. (auth)

22836 IMPROVED COMPUTER SIMULATION OF THE DETECTION PROCESS IN NE-102 AND NE-213 SCINTILLATORS FOR 0 TO 4.8 MeV NEUTRONS. Lindstrom, W. W.; Anderson, B. D. (Case Western Reserve Univ., Cleveland). Nucl. Instrum. Methods; 98: No. 3, 413-17(1972).

A description is given of a FORTRAN subroutine which, in conjunction with a Monte-Carlo main program, accurately simulates the experimentally observed variation of detector efficiency with neutron energy throughout the discriminator cut-off region. With absolute C(n,n) and H(n,n) cross sections supplied, the program permits determination of the absolute detection efficiency from measurements of relative detection efficiency in this cut-off region. Variations of detector efficiency with incident neutron entry point and direction are also obtainable. (auth)

22837 TIMING WITH HIGH PURITY GERMANIUM COAXIAL DETECTOR. Cho, Z. H.; Llacer, J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 98: No. 3, 461-6(1972).

The timing properties of a high purity Ge coaxial detector are studied and compared with those of a Li-drifted detector of similar size. The 1/r field distribution in a Li-drifted device is modified by fixed space charge in the high purity Ge coaxial detector and this results in a higher and more uniform field distribution in a large portion of the detector volume. The effect is felt particularly in an improved hole collection due to their velocity not being saturated at the 100 to 500 V/mm fields. It is found that hole mobility obtainable in such fields is reduced by a factor of approximately 8 from the value normally specified at low fields. An immediate advantage of high purity Ge coaxial detectors is found, therefore, in a smaller spread in their charge collection times from which an improved time resolution and smaller energy dependent time walk results, particularly at low energies. (auth)

22838 LOCALIZATION OF LOW ENERGY PARTICLES BY MEANS OF A PROPORTIONAL CHAMBER WITH SUBDIVIDED CATHODE. Decker, D.; Epple, E.; Voss, W.; Wagner, H. H. (Univ., Stuttgart). Nucl. Instrum. Methods; 98: No. 3, 477-9 (1972). (In German).

Some aspects of the two-dimensional localization of low energy particles especially those which do not ionize by themselves but produce secondary ionizing uncollimated particles are discussed. The advantages of a special proportional chamber with a cathode divided in strips is discussed in comparison with other possible types of chambers. There is a disadvantage of the strip cathode, however, if there occurs an event, not only one strip but also those in its neighborhood produces pulses. The unwanted pulses are distributed about the "main pulse" with descending amplitudes of the same polarity. A circuit is presented, consisting of two-stage operational amplifiers, providing both a sufficient amplification and the selection of the "main pulse". (auth)

22839 PULSE SHAPE DISCRIMINATION IN INORGANIC AND ORGANIC SCINTILLATORS. II. Winyard, R. A.; McBeth, G. W. (Brighton Polytechnic, Eng.). Nucl. Instrum. Methods; 98: No. 3, 525-33(1972).

Further results on the P.S.D. properties of liquid scintillators obtained using a zero crossing technique are presented. Taking NE213 as an example, a comparison is made between theoretical and experimental P.S.D. performance. The application of P.S.D. techniques to multiple scintillator combinations is also discussed. (auth)

22840 SYSTEM FOR SEPARATING AMPLIFIERS FROM WIRE PROPORTIONAL CHAMBERS. Jones, D. F.; Martin, E. R. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 98: No. 3, 535-40(1972).

A front-end electronics system is described which permits removal of all electronics from multiwire proportional chamber frames and thus optimizes the active to deadspace ratio when such detectors are used in confined spaces. A solution to the concomitant crosstalk and pickup problems is also detailed. (auth)

22841 FAST TOTAL INFORMATION READOUT SYSTEM FOR MULTIWIRE PROPORTIONAL CHAMBERS. Martin, E. R.; Jones, D. F. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 98: No. 3, 541-7(1972).

An electronics readout system to be used with multiwire proportional chambers is described which preserves the intrinsic time resolution of the chamber pulses for high background experiments, allows for an arbitrary number of wire hits on each wire plane in the system, while at the same time optimizing the event rate for the entire data transfer to the computer and tape in binary-coded format. (auth)

22842 LITHIUM ALLOYING PROCEDURE FOR GERMANIUM DETECTORS. Robertson, R.; Kennett, T. J. McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 98: No. 3, 599-600(1972).

A variation on the molten salt lithium electroplating method for germanium detector fabrication is outlined. This variation overcomes some of the disadvantages of the LiCl–KCl systems. (auth)

22843 PRELIMINARY RESULTS ON A CdTe PROBE. Martini, M. (Simtex Industries, Montreal); Montano, H.; Zanio, K. Nucl. Instrum. Methods; 98: No. 3, 611-12(1972).

An experimental probe was fabricated from semi-insulating CdTe and compared with a standard Si(Li) medical probe. The count rate for 122 keV gamma rays from ^{57}Co was higher in the CdTe device by a factor of 150. (auth)

22844 PULSE SHAPE DISCRIMINATION CIRCUIT. Bormann, M.; Schroeder, V.; Scobel, W.; Wilde, L. (Univ., Hamburg). Nucl. Instrum. Methods; 98: No. 3, 613-15(1972).

An electronic circuit for the pulse shape analysis used for the discrimination of α-particles with energies down to 1.5 MeV against an intensive proton and gamma background is described. (auth)

22845 APPLICATION OF A SANDWICH OF THIN PLASTIC SCINTILLATORS OF VARIOUS DIAMETERS FOR LOW-BACKGROUND β-SCINTILLATION MEASUREMENTS IN ANTICOINCIDENCE. Dimchev, T. (Inst. of Physics, Sofia). Isotopenpraxis; 7: No. 11-12, 452-5(Nov-Dec 1971).

An examination is made of the possibilities of a symmetrical system of two scintillation detectors with thin polymeric scintillators of various diameters for low-background measurements. A high sensitivity is sought in serial determinations of β-activities through the utilization of a screening detector with a thin plastic polymer scintillator connected in an anticoincidence circuit with the measuring detector. Light reflectors and a β-particle backscatterer are applied. A minimum of radiation shielding is utilized. The method is intended for practical measurements of low-level activities in a non-specialized laboratory. (auth)

22846 NOTE ON THE ENERGY SCALE OF THE MICHIGAN OSO III ION CHAMBER. Teske, Richard G.; Hodge, Philip E.; Worden, Simon P. (Univ. of Michigan, Ann Arbor). Solar Phys.; 22: No. 1, 235-9(Jan 1972).

The energy scale of the Michigan OSO-III soft x-ray ion chamber was assessed by using realistic theoretical x-ray spectra. Multiplicative factors by which the data may be corrected are proposed. The factors are only slightly temperature-dependent. A test of the proposed energy scale indicates it is still somewhat uncertain. (auth)

22847 IMPROVED RESOLUTION OF THE ANGER SCINTILLATION CAMERA THROUGH THE USE OF THRESHOLD PREAMPLIFIERS. Kulberg, G. H. (Nuclear-Chicago Europa, Amsterdam); van Dijk, N.; Muehllehner, G. J. Nucl. Med.; 13: No. 2, 169-71(Feb 1972).

Theoretical considerations of the position arithmetic network of the Anger scintillation camera show that multipliers which are far from a scintillation in the crystal and which therefore receive small signals do not contribute to the accuracy of the position determination but rather reduce that accuracy. Through the use of threshold preamplifiers (which also incorporate a 0.8-μsec charge collection time) small signals are eliminated and the intrinsic resolution is improved by approximately 25% of which 10% is due to the increased charge collection time. (auth)

22848 TOMOGRAPHIC MAGNIFYING COLLIMATOR SYSTEM FOR THE GAMMA CAMERA. Rudin, S.; Rider, K. L.; Hart, H. E. (City Coll., New York. Montefiore Hospital and Medical Center, Bronx, N. Y.). Contract AEC(30-1)-3936. Radiology; 102: No. 2, 371-3(Feb 1972).

A system is proposed which increases the lateral resolution of the standard tomographic rotating collimator for the gamma camera. The angled parallel channel collimator is altered by focusing the channels so as to result in an angled convergent channel or magnifying collimator. It is shown that the magnified tomographic image at the camera crystal provided by the proposed system improves the detectability of higher spatial frequencies in the plane of interest. The intrinsic camera modulation transfer function for various frequencies and magnifications is calculated. (auth)

22849 SOURCES OF GAMMA CAMERA IMAGE INEQUALITIES. Morrison, L. M.; Bruno, F. P.; Mauderli, W. (Univ. of Florida, Gainesville. Veterans Administration Hospital, Gainesville, Fla.). J. Nucl. Med.; 12: No. 12, 785-91(Dec 1971).

Quantitative studies of the system response of an Anger camera represented as a 50 × 50 matrix were carried out with a digital computer. Uniform flooding resulted in variations in matrix elements of +32%. A simple program was written to correct these inequalities. The variation in the matrix-element response to a uniform flood was reduced to +4%. The dependence of these correction factors on time, isotope energy, spectrometer window width, collimators, and counting rate was investigated. The stability and resolution is also specified as a function of the total system. (auth)

22850 USE OF MAGNIFYING MULTIHOLE COLLIMATORS IN THE GAMMA-RAY CAMERA SYSTEM. Rudin, S.; Bardfeld, P. A.; Hart, H. (Montefiore Hospital and Medical Center, Bronx, N. Y.). J. Nucl. Med.; 12: No. 12, 831-4(Dec 1971).

It is shown theoretically that the modulation transfer function can be improved by appropriate magnification of the crystal image. A diverging Nuclear–Chicago collimator, inverted to magnify the gamma-ray image at the crystal, was used to scan line and volume phantoms. These pictures appear to be somewhat better resolved than those employing straight-bore collimators. (auth)

22851 RECTILINEAR TRANSMISSION SCANNING OF IRREGULAR BONES FOR QUANTIFICATION OF MINERAL CONTENT. Vogel, John M.; Anderson, Jerome T. (Public Health Service Hospital, San Francisco). J. Nucl. Med.; 13: No. 1, 13-18(Jan 1972).

A system which permits accurate and reproducible evaluation of bone mineral content is described. By utilizing the gamma absorption principle, various uncertainties of the radiographic approach are eliminated. The use of automated multi-row scanning and data handling techniques permits study of irregular bones as well as the more regularly-shaped bones of extremities which can be studied by single-line scans. The system's usefulness has been confirmed through its successful use in long-term studies of bed-rest subjects. (auth)

22852 METHOD FOR REDUCING THE ENERGY DEPENDENCE OF THE RESOLUTION OF FOCUSED COLLIMATORS. Wyper, D. J.; Gillespie, F. C.; Hall, Irene (Western Regional Hospital Board, Glasgow). J. Nucl. Med.; 13: No. 1, 19-24 (Jan 1972).

It is shown that the addition of mid-penumbral shielding at the inlet and outlet faces of a focused collimator considerably reduces the deterioration in resolution with increasing incident photon energy. In particular, it is shown that the comparative optimum response wavelength of a collimator incorporating mid-penumbral shielding increases from 2.3 cm for 27-keV photons, to 2.9 cm for 48-keV photons, and to 3.1 cm for 660-keV photons, whereas for an equivalent collimator of current conventional design, the corresponding comparative optimum response wavelengths are 2.6, 3.7, and 5.4 cm. The improvements in resolution characteristics are not achieved at the expense of overall performance, as defined using the figure of merit. In fact, in the case considered overall performance is improved. (auth)

22853 INDEX OF RESOLUTION WHEN SEPTAL PENETRATION IS IMPORTANT. Spiegler, P. (Univ. of California, Los Angeles). J. Nucl. Med.; 13: No. 1, 115-17(Jan 1972).

The index of resolution of focused collimators is redefined in terms of the second central moment. This index of resolution depends on the energy of the gamma ray. For low-energy gamma rays, it reduces to the FWHM of the linespread function. (auth)

22854 RADIONUCLIDE IMAGING DEVICES. Hardin, Virgil M.; Johnston, Gerald S. (Letterman General Hospital, San Francisco). J. Surg. Oncol.; 3: No. 6, 603-7(1971).

The principal imaging devices used in clinical and research medicine are mentioned with a more detailed discussion of the instruments used in clinical practice and the modified devices presently in operation at Donner Laboratories. Radionuclide imaging techniques have become remarkably sophisticated since the first mechanical scanner was introduced 20 years ago. Today, high-resolution scintigrams can be produced in minutes, and sequential images, each requiring only a few seconds, provide data on blood flow distribution and organ function. Tomographic imaging has further extended the capability and reliability of organ imaging. (auth)

22855 COMPUTER APPLICATIONS IN RADIONUCLIDE IMAGING. Green, Michael V. (Letterman General Hospital, San Francisco). J. Surg. Oncol.; 3: No. 6, 609-15(1971).

Computers for display, data manipulation, quantitation, diagnoses, and tomography offer the potential of improving the diagnostic efficacy of radionuclide imaging procedures. Although one may legitimately take issue over the question of expense vs. results using present computer systems and techniques, it remains an undeniable fact that if the demand for quantitative information and its manipulation increases, the computer must eventually come to play a central role in nuclear medicine. Indeed, as the phenomena taken under study increase in complexity, perhaps evolving into multiparameter studies, the computer will necessarily be required to present these data in a form meaningful to the physician. This refinement of technique is readily applicable to oncological studies. (auth)

22856 ELECTRONIC RADIOACTIVE SENSING AND SCANNING DEVICE. Slingluff, Jack E. U. S. Patent 3,621,251. 16 Nov 1971. Filed 16 Apr 1969.

An observer's cathode-ray tube is provided with a cathode-ray beam generator connected to a circuit responsive to light produced on the surface of a radiosensitive light-producing member in response to the conjoint effect of radiation to be observed and a beam such as a cathode-ray beam, caused to sweep the surface of the radiosensitive light-producing unit. The circuit is so adjusted that the beam of the observer's cathode-ray tube is intense enough to produce a light spot on its screen only when the radiosensitive light-producing sheet is exposed to radiation to be observed. Sweep circuits are provided which are synchronized so that beams sweep the light-producing surface and the screen of the observer's cathode-ray tube in the same pattern. Consequently, the configuration of radiation reaching the radiosensitive, light-producing sheet is reproduced on the screen of the observer's cathode-ray tube and the observation may be made at a distance from the source of radiation to be observed. (auth)

22857 SCINTILLATION CAMERA. (to Picker Corp.). British Patent 1,261,985. 2 Feb 1972. Priority date 25 Jun 1968, United States.

A scintillation camera comprising a collimator, a large circular scintillation crystal with a peripheral light absorption region to reduce light scattering, and a photomultiplier array is described. (W.H.K.)

22858 CASSETTE MAGNETIC TAPE RECORDING SYSTEM FOR RADIOISOTOPE SCANNERS. Vilensky, A. (Alef Research and Development Ltd., Haifa, Israel); Tatcher, M.; Lifschitz, D. Int. J. Appl. Radiat. Isotop.; 23: No. 3, 129-31(Mar 1972).

A simple and inexpensive system is described for recording and playing back radioisotope scans. The system is based on a standard cassette tape recorder which records the detector pulses and position information in sequence on one track of the tape. When a cassette system is employed, routine tape recording of scans is more convenient than with other systems in use. Examples are given of original scans compared with replays produced under different instrumental conditions. (auth) (UK)

22859 INTRINSIC PLANE SENSITIVITY: A NEW PARAMETER MOST SUITABLE FOR EVALUATION AND COMPARISON OF MOVING AND/OR STATIONARY SCANNERS. Sharma, R. R. (Post-Graduate Inst. of Medical Education and Research, Chandigarh, India). Int. J. Appl. Radiat. Isotop.; 23: No. 3, 121-8(Mar 1972).

A unified theory of the moving and stationary scanners showed that the stationary detector head of a moving scanner constitutes merely a "potential scanner", that a "functioning scanner" gets generated only when the head has described an area, and that the potential scanner is quite distinctly different from the functioning scanner in field properties. Point sensitivity S of a functioning scanner (moving or stationary) is now completely defined as "counts per unit counting time per microcurie" — counting time being the duration for which counts are collected from a point source. For a stationary scanner, counting time is the scanning (exposure) time, but for a moving scanner it is the time taken to describe an area equal only to that enclosed within the contour enveloping peripheral holes on the collimator face of stationary detector head — called its "collecting area". Plane sensitivity of any scanning system S_a is re-defined as equal to the photopeak counts recorded per unit counting time from an infinite plane source placed normally to the central axis and having a uniform surface activity concentration of 1 $\mu Ci/cm^2$. Plane sensitivity per unit effective collecting area of the system is proposed to be recognized as a new parameter: "Intrinsic Plane Sensitivity S_{ai}". It is found that S_{ai} equals S, and is distance independent; S_{ai} for a moving scanner equals that for its stationary detector head. Of two functioning scanners the one having lower $S(= S_{ai})$ but higher S_a — because of much larger scan area — should, on the conventional criterion of S_a, be a better instrument but would produce worse quality scans. This is resolved when S_{ai} replaces S_a as the comparing criterion. Therefore S_{ai} may be used to evaluate/compare moving and/or stationary scanners by both the producers and the users including the ICRU. Experimental evidence is discussed and found to support the theory. (auth) (UK)

22860 TOMOGRAPHIC RADIATION CAMERA WITH MECHANICAL READOUT. Bergstedt, Lowell C. (to Nuclear-Chicago Corp.). U. S. Patent 3,631,244. 28 Dec 1971. Filed 13 Mar 1969.

An Anger-type radiation detector fitted with synchronously rotating slanted-hole collimators adjacent to the crystal and output phosphor screen to enable tomographic imaging of a three-dimensional distribution of radionuclides in an object is described. Alternatively, a precessing film plane viewing the output screen may be synchronized with the rotating collimator adjacent to the crystal to provide a selected in-focus image of a plane through the object. (7 figures) (auth)

22861 MULTIPURPOSE CALIBRATING BENCH. Castro, Victoria G.; Kopenhaver, James F. (Albert Einstein Medical Center, Philadelphia). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 114: No. 1, 186-7(Jan 1972).

A bench for the calibration of radiation safety survey meters is described. (W.H.K.)

22862 DETERMINATION OF GRAIN COUNTING EFFICIENCY IN AUTOHISTORADIOGRAMS. Friedlaender, J. B. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 10, 1171-4(1971).

A method is advanced for the determination of counting efficiency in grain counts. It is shown that the efficiency is a function of the grain density and, hence, cannot be ignored in relative measurements. The method also permits the selection, on quantitative grounds, of the microscopists fit for this type of measurements. (1 figure, 1 table) (auth)

22863 METHOD AND APPARATUS FOR EXTERNAL STANDARDIZATION OF LIQUID SCINTILLATION SAMPLES. Shevick, Phillip (to Nuclear-Chicago Corp.). U. S. Patent 3,609,361. 28 Sep 1971. Filed 20 Sep 1968.

A radioactive source material of the type producing substantially coincident penetrating and non-penetrating radiations is dispersed throughout a scintillating medium positioned external and adjacent to a liquid scintillation sample. A substantial number of the penetrating radiations produce scintillations in the sample and substantially all of the nonpenetrating radiations produce tag scintillations in the external medium. Separate detectors for sample and tag scintillations produce either coincident or anti-coincident output pulses depending upon whether the detected event is a standardizing or a sample event, and logic circuitry is provided to count, simultaneously or in sequence, sample pulses and standardizing pulses. (4 figures) (auth)

22864 CALCULATION OF THE Ge(Li) DETECTOR PROMPT COINCIDENCE CURVE. Poenaru, D. N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 10, 1083-92 (1971).

A straightforward numerical method for the calculation of the Ge(Li) detector prompt coincidence curve is presented. This method is well suited for detectors with low geometry factors whose time resolution is essentially determined by the dispersion of the collection time (not altered by the noise). The calculation time with this method is shorter than in the case of one based on an analytical relationship but also involving computer processing (numerical integration). The listing of a program, written in the FORTRAN IV language, for a particular case is given as an example. (5 figures, 2 tables) (auth)

22865 DETERMINATION OF HIGH INTEGRAL THERMAL NEUTRON FLUXES BY GOLD FOIL ACTIVATION. Danis, Ana; Rebigan, Fl.; Savu, V.; Sandu, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 10, 1213-19(1971).

The gold foil activation method is used to measure integral fluxes in the range of 10^{14} to 10^{16} thermal neutrons per cm^2. Such high fluences were obtained in the VVR-S reactor channels of the Institute of Atomic Physics, Bucharest. Specific problems occurring at high neutron dose measurements as well as their correction factors and errors are presented. The results obtained with the aid of two devices for activity measurement are given together with their overall errors of 8% and 6%. (1 table) (auth)

22866 LIQUID SCINTILLATION COUNTING COMPOSITIONS. (to Monsanto Co.). British Patent 1,264,045. 16 Feb 1972. Priority date 4 Feb 1969, United States.

Improvements in materials used for liquid scintillation counting of slow neutrons and gamma rays are described. The material consists of at least 30% by weight of scintillator solution and a loading agent. For thermal neutrons the loading agent comprises an aqueous solution of a compound of an element having a large neutron capture cross section; for gamma rays the loading agent comprises an aqueous solution of a compound of an element having a large gamma absorption cross section. (2 tables) (R.W.R.)

22867 RADIATION DETECTOR. Meuleman, J. (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 884,583. 26 Oct 1971. Priority date 9 Oct 1967, France.

The detector utilizes a semiconductor with a back-biased rectifying junction and an electrode on the radiation-incident side of the detector. On the opposite side, the linear resistance between the spaced electrodes is provided by an epitaxial layer. This layer has the same conductivity but a lower resistivity than that of the underlying body. (F.S.A.) (Canada)

Radiation Dosimeters

Refer also to abstracts 23081, 23083, and 23162.

22868 RADIATION DETECTOR. (to Instytut Badan Jadrowych). British Patent 1,265,166. 1 Mar 1972. Priority date 5 Mar 1968, Poland.

A tissue equivalent differential ionization chamber for measuring the dose equivalent of mixed radiation is described. (W.H.K.)

22869 2.00-MeV ELECTRON DEPTH-DOSE MEASUREMENTS IN ALUMINUM, COPPER, AND TIN ABSORBERS USING A RADIOCHROMIC DYE FILM. Eisen, H. (Univ. of Maryland, College Park. National Bureau of Standards, Washington, D. C.); Rosenstein, M.; Silverman, J. Int. J. Appl. Radiat. Isotop.; 23: No. 3, 97-108(Mar 1972).

The use of radiochromic dye films (hexahydroxyethyl pararosaniline dye cyanide in nylon) for electron dosimetry has been extended to absorbers with atomic numbers in the range 13 to 50. The depth-dose profiles in slab targets of aluminum, copper, and tin irradiated by a plane parallel 2.00-MeV electron beam are pre-

sented for incident beams at 0, 30, and 60 degrees with respect to the surface normal. Absolute energy deposition per unit fluence was determined by using calibrated films, a fluence measurement, and a stopping-power ratio correction. The results are compared with the ionization measurements of Nakai and to the theoretical calculations of Berger and Siltzer; all agree within 10 percent. The stopping-power ratio, necessary to convert dose in the dye film to absorber dose at that point, is determined three ways and the results compared. The three techniques range from a detailed computer transport calculation yielding a variable stopping-power ratio with depth to the use of a constant stopping-power ratio obtained from tabulations. It is demonstrated that the use of the constant stopping-power ratio gives depth-dose distributions that differ by no more than 1 to 2 percent for aluminum, 3 to 5 percent for copper, and 4 to 8 percent for tin from the results obtained with the more rigorously evaluated stopping-power ratios. (auth) (UK)

22870 SIMPLE TECHNIQUE FOR MAKING NEUTRON MEASUREMENTS. Kehrer, M. L.; Robinson, J. E. (Univ. of Maryland, Baltimore). Int. J. Appl. Radiat. Isotop.; 23: No. 3, 141-2(Mar 1972).

Track detectors composed of polycarbonate (Lexan, 0.15 mm thick, 1.7 cm dia.) sandwiched between depleted uranium fission foils (0.03 mm thick and 1.25 cm dia.), were used to measure the neutron flux density in and outside the beam of the Brown–Boveri medical betatron at the University of Maryland School of Medicine in Baltimore. Preliminary fast neutron measurements indicated that the neutron beam dropped off very slowly compared with the x-ray beam, where photofission of ^{238}U contributed to the difference between in-beam and out of beam measurements. (UK)

22871 USE OF THE SYSTEM METHYL ORANGE/POLYVINYL ALCOHOL FOR THE DETECTION OF IONIZING RADIATION. Huebner, K. (Technische Univ., Dresden). Isotopenpraxis; 7: No. 11-12, 439-46(Nov-Dec 1971). (In German).

A solid-body colorimetric dosimeter is described for detection of ionizing radiation through discoloration of methyl orange in polyvinyl alcohol. Investigation is made to determine discoloration as a function of dye concentration and foil thickness. In order to find out the optimum system, the properties most important for dosimetric purpose are checked: the influence of the absorbed dose rate and radiation characteristic (energy, LET) upon the discoloration process, influence of irradiation temperature, stability of discoloration after irradiation, storage stability of nonirradiated foils, and reproducibility of the foil production process. Comments are made on the reaction mechanism as well as on possible fields of use of the colorimetric dosimeter. (25 references) (auth)

22872 SOME RECENT METHODS FOR NEUTRON PERSONNEL MONITORING. Nikodemova, Denisa (Inst. of Industrial Hygiene and Occupational Medicine, Bratislava). Jad. Energ., 17: No. 9, 312-15(Sep 1971). (In Slovak).

Although nuclear emulsions are still the most widely used personnel dosimeters for fast neutrons dose equivalent measurements, they do not completely meet all desired requirements. A review of some new dosimetric techniques for neutron personnel dosimetry is presented. The method of nuclear track registration with a combination of fissionable materials and plastics, LiF thermoluminescent dosimeters with and without moderators, and the activation technique are discussed. (52 references.) (auth)

22873 VERSATILE DOSE AND DOSE RATE METER. Karzmark, C. J.; Rust, D. C. (Stanford Univ., Calif.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 114: No. 1, 181-5(Jan 1972).

An ionization chamber instrument has been developed for use as a dose and dose rate meter. The unit is robust and its design facilitates the accurate, precise measurement of a wide variety of radiation beams. The unit consists of a probe ionization chamber on a cable and a high impedance operational amplifier together with digital readout. (auth)

22874 IN VIVO DOSIMETER FOR FAST NEUTRONS. Field, S. B. (Hammersmith Hospital, London). Brit. J. Radiol.; 44: No. 527, 891-2(Nov 1971).

A technique is briefly described for measuring the dose distribution of fast neutrons by aluminium activation and subsequent scintillation counting of the γ radiation resulting from the reaction $^{27}Al(n,p)^{27}Mg$. Results are given comparing the depth doses of two types of neutron beam (cyclotron and D–T reaction neutrons) in liquid phantoms measured by aluminium activation and ionization chambers. The dosimetry of irradiation of a carcinoma of the bronchus was checked by placing pellets of 99.99% pure aluminium in an oesophageal tube which was swallowed. Tabulated results are presented showing estimates of the exit dose and dose in the oesophagus obtained (a) directly from the depth dose curves measured in unit density tissue, (b) from the depth dose curves corrected for lung density = $\frac{1}{3}$ g cm^{-3}, (c) measured by aluminium activation. (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 23187 and 23199.

22875 (AD–731120) EXPERIMENTS IN NUCLEAR PHYSICS USING BEAM PULSING AND TIME OF FLIGHT SYSTEMS. Final Technical Report. Purser, Kenneth H. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1971. Contract AF49(638)-1707. 49p. (AFOSR-TR-71-2652). NTIS.

The contract supported a program for the installation and use of a time-of-flight facility. The report describes the major features of the work done during the period on the pulsed beam project. It can be divided into three major sections: a description of the pulsed beam facility and the features of its design, the experimental program and results, and an attempt to study damage effects in calcogenous glasses. (auth) (GRA)

22876 (CEA-N–1489) STUDIES OF NEUTRON SPECTRA OBTAINED FROM THE UNFOLDING OF PULSE-HEIGHT SPECTRA PRODUCED BY RECOIL PROTONS IN AN ORGANIC LIQUID SCINTILLATOR. Lepretre, Alfred; Garganne, Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 37p. (In French). Dep. NTIS (U. S. Sales Only).

Proton recoil pulses obtained when a neutron beam is incident on an organic liquid scintillator such as NE 213 were unfolded into the incident neutron energy spectrum and the corresponding total neutron flux. The simplicity of the detector set-up and its associated electronics for the 800 keV $\leq E \leq$ 18 MeV neutrons used in this method compare favorably with most of the techniques used in other neutron spectrometry methods. Pulsed as well as continuous neutron fluxes of relatively weak intensities can be measured with this system. The absolute flux as well as the energy spectrum of the neutrons obtained using a Van de Graaff accelerator were measured. (France)

22877 (CEA-N–1500) GAMMA-RAY SPECTROSCOPY USING Ge DETECTORS; APPLICATION TO THE $^{64}Ni(n,\gamma)^{65}Ni$ REACTION. Girard, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 61p. (In French). Dep. NTIS (U.S. Sales Only).

An improved Ge(Li) anti-Compton pair spectrometer is described. It consists, essentially, of an annular NaI crystal, divided into six sectors, and a plane Ge(Li) detector, having a volume of 28 cm^3. A critical analysis of the system is presented. Problems associated with the precise determination of the nuclear interaction time are discussed, with emphasis on the constant fraction determination method. This method can be adapted with the appropriate time coincidence treatment, to extend the amplitude range in which a valid analysis can be applied. Finally, 22 out of 39 measured γ transitions from the $^{64}Ni(n,\gamma)^{65}Ni$ reaction were attributed to excited levels of the ^{65}Ni nucleus. The neutron binding energy (Bn) of Ni was found to be 6098.3 ± 3 keV. (France)

22878 (KFKI–71-67) COMPLETE PACKAGE OF PROGRAMS FOR THE EVALUATION OF MOESSBAUER AND GAMMA SPECTRA. Kulcsar, K.; Nagy, D. L.; Pocs, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1969]. 10p. (CONF-710947–1). Dep. NTIS (U. S. Sales Only).

From fourth international conference of the socialist countries on Moessbauerspectrometry; Dresden, Germany (20 Sep 1971).

A set of interlinking Algol 60 programs able to handle and evaluate Moessbauer and gamma spectra is described. A rather general Moessbauer fitting method taking into account several constraints is given. The use of the method is illustrated by the analysis of lunar fines turned by Luna 16. (auth)

22879 (ORNL-TM–3676) EVALUATION OF THE POSSIBILITY OF DETECTING AND IDENTIFYING ALPHA EMITTERS IN LOW-COUNT-RATE SAMPLES USING SOME NEW LIQUID SCINTILLATION COUNTING TECHNIQUES. McDowell, W. J.; Henley, L. C. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 13p. Dep. NTIS.

Several tests in which a high-resolution liquid scintillation method was applied to samples having a low count rate (i.e., urine samples and waste water) are described. With the present shielding and resolution, the identification of an alpha energy to ±0.1 MeV at a count rate as low as 1 count/min appears to be feasible. Since many waste or environmental samples are above this count rate, application of this method to such samples ap-

pears attractive. Methods of improving energy resolution and reducing background are noted. (9 figures) (auth)

22880 (RCN–159) REMARKS ON THE GOODNESS-OF-FIT AND THE CONSISTENCY OF OBSERVATIONS IN GAMMA SPECTROMETRIC ANALYSIS. Zijp, W. L. (Reactor Centrum Nederland, Petten). Dec 1971. 30p. Dep. NTIS (U. S. Sales Only).

The goodness-of-fit parameter, $\omega = (\chi^2/\nu)^{\frac{1}{2}}$, as obtained in the method of least squares is considered for the one parameter case, the two parameter case, and the multi-parameter case. When counting statistics apply to the ordinates and the abscissae are free from errors and the fitting function is not ideal, the parameter ω will be proportional to $N^{\frac{1}{2}}$ where N is the number of events registered and used in the analysis. Large values of ω indicate a bad fit, but this does not indicate that for smaller N the fitting model is likewise bad. A large ω does not imply that the fitting model is inadequate for the whole range of counting rates. It indicates systematic inconsistencies between experimental points and the fitting function on the whole range of counting rates, if also the quantity $(\omega^2 - 1)/N$ has a large value. The nature of the inconsistencies may be traced by considering the pattern of signs, magnitudes and autocorrelations of the successive values of $\delta_i/\sigma(\delta_i)$, which arise when the parameters occurring in the fitting function have their best values. (auth)

22881 (RD/B/N–2024) PASSIVE GAMMA SPECTROMETER FOR USE IN HIGH FLUXES IN THE ENERGY RANGE .01 TO 10 MeV. Gayton, F. M.; Longworth, J. P. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct 1971. 39p. Dep. NTIS (U. S. Sales Only).

The feasibility of using the attenuation property of shields of various thicknesses for gamma spectroscopy is discussed, together with the criteria for choosing the shield materials and thicknesses. The construction, calculation of the energy response matrix, and the testing of such a spectrometer is described. A response matrix covering the range .01–10 MeV was determined. (auth) (UK)

22882 SIMPLE BIASED AMPLIFIER. Bialkowski, J.; Karnicki, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods; 98: No. 3, 509–11(1972).

The principle of operation and a circuit diagram of the biased amplifier are described. Integral linearity equal to 0.1% for the range 0.2 to 10 V, temperature stability -5×10^{-3}/°C per gain factor, and long time stability -0.8×10^{-4} were obtained. (auth)

22883 CADMIUM TELLURIDE FOR LOW ENERGY GAMMA-RAY AND X-RAY SPECTROMETERS. Palms, J. M. (Emory Univ., Atlanta); Wood, R. E.; Puckett, O. H.; Zanio, K. Nucl. Instrum. Methods; 98: No. 3, 597–8(1972).

Cadmium telluride detectors have been fabricated which are useable as low energy gamma and X-ray spectrometers. A threshold energy of 10 keV and a resolution of 9.8 keV (fwhm) were obtained for the 59 keV line from ^{241}Am. K X-ray escape peaks for Cd and Te have been observed. (auth)

22884 RESPONSE FUNCTIONS FOR PROTON-RECOIL PROPORTIONAL COUNTER SPECTROMETER. Bennett, E. F.; Yule, T. J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 98: No. 3, 393–412(1972).

The accurate determination of neutron spectra with proton-recoil proportional counters requires that corrections be made for nonideal electric-field effects and for wall and end effects. The use of field tubes to define a sensitive volume leads to a distortion of the internal field lines near the ends of the sensitive region and produces a counter whose multiplication is a function of position of the event along the anode. Wall-and-end effects are present when some proton-recoil tracks deposit only part of their energy in a sensitive region of the counter. Correction schemes have been obtained for electric-field distortion based on the solution of the electric field everywhere in the counter together with measured multiplication versus voltage data and for wall and end distortion based on analytically determined track length probability functions and measured stopping-power and range-energy data. The investigation of electric-field effects indicated that by using an unconventional counter design in which the diameter of the cathode over the field tube is reduced, it is possible to reduce the influence of electric-field distortion and produce a counter better suited for spectroscopy and absolute counting applications. Calculated pulse-height distributions have been compared with experimentally determined distributions. The extent of corrections for these effects has been assessed for a representative fast-reactor spectrum. (auth)

22885 MINIMUM DETECTABLE PHOTOPEAK AREAS IN Ge(Li) SPECTRA. Head, J. H. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 98: No. 3, 419–28(1972).

Two sources of error in the detection and analysis of small photopeaks appearing in Ge(Li) gamma-ray spectra are discussed. A Type I error arises when fluctuations in the background are falsely identified as true photopeaks. A Type II error occurs when fluctuations in the background obscure true photopeaks to the extent that they are not detected. Experimental measurements on the distribution of fraudulent peaks in Ge(Li) spectra form the basis for numerical calculations of the minimum number of counts in a photopeak which will render it detectable to within preselected risks of committing Type I and Type II errors. This threshold is analyzed in terms of the height of the background under the photopeak. Minimum counting times required to ensure peak detectability are discussed. (auth)

22886 CONSTRUCTION OF EFFICIENCY CURVES FOR SEMICONDUCTOR X-RAY SPECTROMETERS. Campbell, J. L; McNelles, L. A. (Univ. of Guelph, Ont.). Nucl. Instrum. Methods; 98: No. 3, 433–44(1972).

Efficiency curves measured for Si(Li) and Ge(Li) X-ray detectors by the X/γ technique are presented and discussed. Measurements of the X/γ ratio using a 4π CsI(Tl) detector for the calibration sources ^{109}Cd, ^{139}Ce and ^{141}Ce are reported. The situation as regards efficiency calibration is reviewed and further work suggested. (auth)

22887 DESIGN OF A HIGH-RESOLUTION HIGH-EFFICIENCY MAGNETIC SPECTROMETER FOR ELECTRON SPECTROSCOPY. Fadley, C. S.; Healey, R. N.; Hollander, J. M.; Miner, C. E. (Univ. of California, Berkeley). J. Appl. Phys.; 43: No. 3, 1085–1102 (Mar 1972).

A theoretical design study was carried out for a high-resolution high-efficiency double-focusing magnetic spectrometer intended for general use in electron spectroscopy. With the proposed design it should be possible to operate with good intensity at energy resolutions as high as 0.01%. The air-cored system of coils used in the design gives a fieldform with electron-optical properties very close to those of the $1/\sqrt{r}$ field. The design thus has very good focal-plane properties and, in conjunction with a multichannel detector, should yield data-acquisition rates approximately 100 times higher than in single-channel operation. The present design is superior in this respect to any previous air-cored magnetic spectrometer. All coils in the design are of smaller radii than the electron orbits, giving very high access to the source and detector regions. There appear to be no great difficulties in the construction of a spectrometer with this design. Most features of the design compare very favorably with other spectrometers currently used in electron spectroscopy. The effects of extraneous magnetic field perturbations on the performance of double-focusing spectrometers were also calculated. (auth)

22888 MATRIX METHOD TO CORRECT FOR NONLINEAR ENERGY RESPONSE OF SODIUM IODIDE(THALLIUM) [NaI(Tl)] SPECTROMETER SYSTEMS. Waggener, R. G.; Rogers, L. F.; Zanca, P. (Univ. of Texas, San Antonio). Health Phys.; 22: No. 3, 292–4(Mar 1972).

A method to measure the non-linear energy response of a NaI(Tl) system is briefly described. A curve is presented that was derived by exactly centering the 59.5-keV line of ^{241}Am at 59.5 spectrometer channels by varying the high voltage and gain applied to the photomultiplier tube and amplifier. Other monoenergetic photon energies were then centered by measurements made under the same conditions. A 5th degree polynomial was derived using a digital computer relating photon energy and its corresponding position in spectrometer channel units, and selected values over the range 36 to 40 keV are tabulated. The following equation was used to convert observed nonlinear energy response to a linear scale: $N_j(E) = M_{ij}^{-1}(E)N'_j(E)$, where $N_j(E)$ is the true spectrum derived from the observed $N'_j(E)$, and $M_{ij}(E)$ is a square matrix. An example is shown of a 40-kVp tungsten target x-ray unit, with zero added filtration, before and after correction. (UK)

22889 MOESSBAUER GAMMA RAY SPECTROMETER. Barton, Hugh M. Jr. (to Phillips Petroleum Co.). U. S. Patent 3,631,247. 28 Dec 1971. Filed 26 Mar 1969.

A catalyst containing a nuclide which exhibits the Moessbauer effect is irradiated with gamma rays while scanning through resonance conditions, the gamma radiation transmitted through the catalyst is measured, and reactants are contacted with the catalyst as the measurement proceeds. The spectrometer includes appara-

tus for passing a second gamma-ray beam through a second absorbing body of similar characteristics to the body to be analyzed; a signal that is representative of the difference in intensity of the two beams of gamma radiation is produced as a function of velocity. (3 figures) (auth)

High Energy Physics Instrumentation

Refer also to abstracts 22913 and 23925.

22890 (JINR-E13-6194) SELECTIVE TRIGGERING SYSTEM WITH PROPORTIONAL CHAMBERS FOR THE SMALL ANGLE π-p SCATTERING EXPERIMENT AT 40 AND 50 GeV. Guzik, Z.; Hajduk, Z.; Krasowski, R.; Peshekhonov, V. D.; Popielski, E.; Popielski, W.; Silaev, E.; Starchenko, B. M.; Tsyganov, E. N.; Turala, M.; Zanevskii, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 11p. Dep. NTIS (U.S. Sales Only).

The described system allowed the triggering of the magnetic spectrometer with magnetostrictive spark chambers when the required conditions for the scattering angle of the particle were satisfied. Six wire proportional chambers were used as detectors for the decision making analog system. The trigger rate was on an average of about 15 when detecting the particles scattered for the angles greater than 0.5 mrd. The system required about 300 nsec for analyzing one event. (auth)

22891 (JINR-P13-6184) DEVICE FOR INVESTIGATION OF THE RADIATION DECAY RESONANCES. Astvatsaturov, R. G.; Baldin, A. M.; Basiladze, S. G.; (and others) (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of High Energy). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

An on-line two-channel Cherenkov mass spectrometer is described. The detectors composing the spectrometer are considered, as well as electronic apparatus and methods of calculation and control of the basic parameters. The characteristics of the device are presented. (5 figures) (auth)

22892 (SLAC-Trans-140) MEMORY TIME AND SPARK DISPLACEMENT IN NARROW-GAP SPARK CHAMBERS IN A MAGNETIC FIELD. Radkevich, I. A.; Dukhovskoi, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated for Stanford Linear Accelerator Center, Calif., from report ITEF-884. 15p. Dep. NTIS.

Measurements were carried out on the memory time as a function of magnetic field induction in narrow-gap chambers filled with a pure neon-helium mixture or with an admixture of ethyl alcohol. Displacement of the sparks was investigated as a function of the magnetic induction and the clearing electric field. It was found that the spark displacement plotted against the clearing electric field was appreciably nonlinear. (9 figures) (auth)

22893 SAS-B DIGITIZED SPARK CHAMBER GAMMA RAY TELESCOPE. Derdeyn, S. M.; Ehrmann, C. H.; Fichtel, C. E.; Kniffen, D. A.; Ross, R. W. (Goddard Space Flight Center, Greenbelt, Md.). Nucl. Instrum. Methods; 98: No. 3, 557-66(1972).

The SAS-B satellite will carry a gamma ray telescope containing a thirty-two level magnetic core digitized spark chamber system. Thin tungsten plates are interleaved between the spark chamber modules to provide material for the gamma ray to be converted into an electron pair and secondly to provide a means of determining the energy of the electrons in the pair by measuring the Coulomb scattering. The spark chamber assembly is normally triggered if a charged particle passes through one of four telescopes consisting of a plastic scintillator tile in the center of the spark chamber stack and a directional Lucite Cherenkov counter below the spark chambers and, at the same time, there is no pulse in a surrounding plastic scintillator anticoincidence dome. The basic component of the spark chamber assembly is a wire grid spark module, which contains a 25 cm by 25 cm opening across which are strung two planes of 200 parallel and evenly spaced wires. Each of the wires is terminated through a ferrite core which is set by the current which flows when the wire is associated with a spark. (auth)

22894 AUTOMATIC RECOGNITION OF EVENTS ON BUBBLE CHAMBER FILM. Villeneuve de Janti, Ph. (CEN de Saclay, Gif-sur-Yvwtte, France). Nucl. Instrum. Methods; 98: No. 3, 567-72(1972). (In French).

A new method for automatic scanning of bubble chamber films is proposed. Its main feature consists of using a specialized device for detecting information points as vertices, then allowing a fast image analysis which does not need a big computer. (auth)

22895 RELATIVISTIC RISE OF THE TRACK DENSITY IN BUBBLE CHAMBERS. Chechin, V. A.; Kotenko, L. P.; Merson, G. I.; Ermilova, V. C. (Lebedev Inst. of Physcis, Moscow). Nucl. Instrum. Methods; 98: No. 3, 577-87(1972).

The reasons for the high relativistic rise of the track density of fast charged particles in heavy liquid bubble chambers are considered. An approach is suggested which allows a quantitative description of the ionization-energy dependence for relativistic particles in bubble chambers filled with various liquids. This approach takes into account both the polarization of matter and the energy threshold of nucleation in a superheated liquid. The expressions are given for a number of collisions per unit length with the energy transfer exceeding the threshold energy and for the specific energy loss in these collisions. It is shown that the ionization-energy dependence in bubble chambers can be described assuming the track density to be proportional to the number of collisions per unit length with the energy transfer exceeding the definite "effective" threshold energy but not to the specific energy loss in such collisions as usually assumed. This effective threshold energy is found to be several times greater than that calculated according to the thermal theory of nucleation and is close to 1 keV in heavy liquids. The observed relativistic rise of the track density must depend on both the liquid used and the operating conditions of a bubble chamber. Its maximum possible value for bubble chambers filled with H_2, He, C_3H_8, C_3F_8, SF_6, $CBrF_3$, Xe and a mixture of equal volumes of C_3H_8 and $CBrF_3$ is estimated to be 4; 12; 25; 29; 29; 35; 49 and 31 percent of the minimum track density respectively. The low nucleation efficiency of fast charged particles and the possibility of identification of relativistic secondaries according to their ionization in bubble chambers are discussed. (34 references) (auth)

22896 OPERATIONAL CHARACTERISTICS OF LOW PRESSURE SPARK CHAMBERS. Mundra, J. P.; Majumdar, D.; Majumdar, K.; Mukherjee, J.; Choudhury, P. K. Sen (Presidency Coll., Calcutta). Nucl. Instrum. Methods; 98: No. 3, 589-94(1972).

Efficiency of parallel plate spark chambers having different gap widths has been measured as a function of applied voltage and gas pressure for cosmic ray muons of mean energy 4 GeV in the pressure range 5 to 750 torr. A linear relationship analogous to Paschen's Law for the quantities threshold voltage, argon pressure and gap width has been found to hold with a gradient K = 141.4 dyne V^{-1} cm^{-1}. With a fixed plate voltage 10 kV, the efficiency remained substantially flat at nearly 100% in the pressure range 100 to 550 torr. Beyond these limits it was observed to fall steeply. The efficiency characteristics with argon fillings below 100 torr for the same plate voltage have shown that the threshold pressure down to which only defined sparks are possible was 30 torr; with an alcohol contamination of 20% with argon this pressure could be further lowered to about 22 torr. Below this pressure undefined sparks in addition to defined ones appeared across the spark gaps along the path of the ionizing radiation. The behavior towards the net efficiency of defined and undefined sparks was analyzed. (auth)

22897 TRACKS STORAGE IN OPTICAL SPARK-CHAMBERS. Piccolo, M.; Ronga, F. (EN, Frascati, Italy). Nucl. Instrum. Methods; 98: No. 3, 455-9(1972).

A new technique in optical spark chamber pulsing is described, which allows tracks storage for a time of the order of 10^{-3} sec. The mechanism producing this effect is discussed together with tests performed with different experimental conditions. The results obtained show that storage is possible with no loss in efficiency and without significant distortion of inclined tracks. (auth)

22898 SIMULATION OF PARTICLE TRACKS IN EMULSION. Furtak, T. E.; Katz, R. (Univ. of Nebraska, Lincoln). Radiat. Eff.; 11: No. 3-4, 195-9(Dec 1971).

Micrographs of energetic particles in nuclear emulsion were simulated by computing the spatial distribution of developed grains with the δ-ray theory of track structure, and representing the developed grains by points of light on an IBM 2250 visual display unit. The simulated tracks displayed many of the features of actual track structure and served as a visual comparison between experiment and theory. (auth)

Radiometric Instruments

22899 RADIOMETRIC MOISTURE AND DENSITY MEASUREMENT USING A SINGLE DETECTOR. Novakova, O.; Slezak, V. (Tesla, Premysleni, Czech.). TESLA Electron.; 4: No. 1, 16-24(Mar 1971).

A comparison is made of the sensitivity of various sensors of neutron and gamma radiation. Electronic methods of processing

signals from scintillation detectors so as to permit selective measurement of the two radiation types are discussed. For radiometric measurements of moisture content and density, a detector with a Li-glass scintillator attached to the photocathode of a photomultiplier was employed with an Am–Be neutron source and a ^{137}Cs gamma source. Pulse-height discrimination was used. The results were used to design the first Czechoslovak radiometric sets for measuring moisture content and density. The set for subsurface measurements, TESLA NZK 201, can be employed in depths of from 35 cm to 10 m. The TESLA NZK 202 set can be used for measurements of moisture content and density in depths up to 15 cm, and using the method of placing the source beneath the surface, for density measurements in depths up to 35 cm. (INIS)

22900 DEVICE FOR MEASURING THE THICKNESS OF METALLIC LAYERS UTILIZING BETA RAY BACKSCATTERING. Streng, Ludwig U. S. Patent 3,639,763. 1 Feb 1972. Filed 22 Jan 1970.

Block diagrams and calibration curves for a beta backscattering thickness gage for metallic layers are presented and discussed. (W.H.K.)

22901 MINERAL-DETECTION APPARATUS. Duffey, Dick; Wiggins, Peter F.; Senftle, Frank E. (to United States Atomic Energy Commission). U. S. Patent 3,638,020. 25 Jan 1972. Filed 26 May 1970.

A marine mineral-detection apparatus is described including a ^{252}Cf source of neutrons and a lithium-drifted germanium radiation detector shielded from the neutron source. The neutron source is mounted on an extensible member supported within a mass of neutron-shielding material. The source is extended outside the neutron shield to bombard surrounding mineral values with neutrons. Elements capturing neutrons give off prompt gamma radiation with discrete energies. The radiation detector resolves the radiation into distinct energy peaks for identifying the elements present in the mineral values. (auth)

22902 ROLE OF MEASUREMENT GEOMETRY IN SOME PRACTICAL PROBLEMS OF RADIOISOTOPIC MOISTURE DETERMINATION. Toth, E.; Vereczky, L. (MTA Izotop Intezete, Budapest). Izotoptechnika; 14: No. 12, 588-93(Dec 1971). (In Hungarian).

Calculation of the maximum sensitivity range of measurement as a function of radius of a sphere for data collection based on neutron physics is described. (auth)

22903 MEASUREMENT OF SULFUR CONTENT IN HYDROCARBON WITH RADIOISOTOPE. DIGITAL INDICATION TYPE SULFUR ANALYZER. MODEL AGK-77108. Inoue, Yuichiro; Sakaki, Masamichi; Fukabori, Teruo (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu; 26: No. 10, 1252-5(Oct 1971). (In Japanese).

The chemical analysis for measuring the sulfur content in hydrocarbons, though generally used, requires great skill and much time. In addition, it is well known that measurements made by the method are accompanied by noticeable personal errors. Since the public nuisance due to SO_2 has become a burning problem, an increase of the accuracy, speed, and ease of sulfur content measurement is vital. Toshiba has developed a new device that meets these requirements. With this apparatus, just setting a button digitally indicates in several minutes the sulfur content in a definite quantity of a sample in a container on the measuring stand. By combining it with several kinds of supplementary devices, it can measure many kinds of samples. (auth) (Japan)

22904 RADIOISOTOPE ANALYTICAL INSTRUMENT FOR CEMENT ANALYSIS OF CONCRETE. Berry, Peter Francis; Hall, James D. (to United States Atomic Energy Commission). U. S. Patent 3,626,183. 7 Dec 1971. Filed 15 Jul 1970.

A portable radioisotope instrument was developed for field cement analysis with an accuracy of 1 to 2% cement in wet concrete. The instrument consists essentially of a cylindrical depth probe unit in which a pair of γ-ray sources of different energy and a detector are arranged in coaxial alignment; the output of the detector is coupled to a portable scaler. The detector is shielded from the source so that only the γ-backscattered radiation is detected; through proper calibration of the device as to the aggregate type the operator can radially analyze a wet mix by inserting the probe into the mix and measure the two radiation intensities with reference to the proper calibration curve to determine the cement content. (4 figures) (auth)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

22905 (N-72-10372) SPACE RADIATION HAZARDS TO PROJECT SKYLAB PHOTOGRAPHIC FILM, PHASE 2. Final Report. Hill, C. W.; Neville, C. F. (Lockheed-Georgia Co., Marietta). Oct 1971. Contract NAS8-26441. 125p. (NASA-CR-61364; ER-11192). NTIS.

The results of a study of space radiation hazards to Project Skylab photographic film are presented. Radiation components include trapped protons, trapped electrons, bremsstrahlung, and galactic cosmic radiation. The shielding afforded by the Skylab cluster is taken into account with a 5000-volume-element mathematical model. A preliminary survey of expected proton spectrometer data is reported. (auth) (STAR)

22906 DETERIORATION OF LARGE Ge(Li) DIODES CAUSED BY FAST NEUTRONS. Stelson, P. H.; Dickens, J. K.; Raman, S.; Trammell, R. C. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 98: No. 3, 481-4(1972).

The large Ge(Li) gamma-ray detector has become a powerful tool for the investigation of nuclear reactions. Unfortunately these detectors are quite susceptible to fast neutron damage and this makes it difficult to decide whether or not to risk using a detector to study reactions at accelerators where fast neutrons are inevitably present. After ruining several detectors it was decided to study the problem in a controlled way. A 30 cm^3 true coaxial diode was systematically irradiated by neutrons from a plutonium–beryllium source. An increase in the width of the 2.614 MeV gamma-ray from ^{208}Tl was first detected after an irradiation of 5×10^7 n/cm^2. When the total irradiation had reached 6×10^8 n/cm^2, the peak width had increased by more than 50 percent. The irradiated detector was then reprocessed to remove the damage. The diode was again subjected to neutron irradiation. The second curve of resolution deterioration as a function of neutron flux was quite similar to the first one. The procedure was repeated a third time with similar results. Thus, reprocessing a detector effectively removes the neutron damage at a cost of only about 10 to 15 percent of the original price. A method was also developed for using the gamma-ray spectrum to evaluate the amount of neutron flux incident on the detector. The number of counts in the 693 keV peak [from (n,n') reaction with the ^{72}Ge in the detector] can be multiplied by 20 to get a rough measure of the neutron flux in n/cm^2. (auth)

22907 NEUTRON DAMAGE AND ANNEALING IN HIGH PURITY GERMANIUM RADIATION DETECTORS. Llacer, J.; Kraner, H. W. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 98: No. 3, 467-75(1972).

The neutron damage and annealing characteristics of five high purity Ge planar radiation detectors have been studied. Irradiation with fast neutrons in several steps and annealing at different temperatures has given data on neutron radiation resistance of the devices and on the recovery of the original characteristics after damage. It is found that resolution characteristics begin to be degraded at an integrated dose of approximately 10^{10} n/cm^2, very much like in the case of Li-drifted detectors. Annealing of the damage can be accomplished readily by heating to 250°C for periods of about 1 h. It is observed that the recovered detectors exhibit better resolution than before the damage–anneal cycle. This phenomenon has been investigated by Hall effect measurements on two samples of high purity Ge and it is found that the damage–anneal cycle results in the change of the electrical properties of deep acceptor levels caused by impurities to the effect that they cease behaving like ionized acceptor traps. (auth)

22908 SUGGESTIONS FOR HARDENING MIS DEVICES AGAINST RADIATION. Esteve, D.; Buxo, J.; Martinez, A.; Chapeau, A. (CNRS, Toulouse). Thin Solid Films; 9: No. 3, 471-5(Mar 1972).

The injecting cathode model of Andre et al. (Solid State Electr., 10(1969) 123) is discussed, and the analytical extensions of this model are applied to develop methods for hardening a MOS transistor against ionizing radiation. (W.H.K.)

22909 IMPROVED ELECTRO-OPTIC MATERIALS AND FIXING TECHNIQUES FOR HOLOGRAPHIC RECORDING. Amodei, J. J.; Phillips, W.; Staebler, D. L. (RCA Labs., Princeton, N. J.). Appl. Opt.; 11: No. 2, 390-6(Feb 1972).

Recent improvements in materials and techniques for storage of

high-efficiency phase holograms in electro-optic crystals are described. The storage performance of lithium niobate and barium sodium niobate was greatly enhanced by introducing transition metal impurities or by subjecting the undoped crystals to irradiation treatments. The latest materials combine good sensitivity with diffraction efficiencies that reach well over 50% for sample thickness of a few millimeters. In addition, the fixing techniques that were developed offer a simple means of achieving nondestructive readout for holographic information stored in these crystals. (auth)

22910 ANALYSIS OF THE RADIATION-INDUCED DEGRADATION IN LATERAL pnp TRANSISTORS. Palkuti, Leslie John Jr. Columbus, Ohio; Ohio State Univ. (1971). 176p. University Microfilms Order No. 72-4601.

Thesis.

Experimental devices fabricated by six-mask planar technology were irradiated in a nuclear reactor and pure gamma irradiation environments and electrically characterized before and after each irradiation. The collector- and base-current–voltage characteristics were studied via a two-dimensional model in order to relate the device terminal response to physical and geometric parameters after irradiation. Good agreement was obtained between calculated values and experimental results. At low radiation levels and high currents, the decrease in collector current was linear with neutron fluence. The increased lifetime damage at low injection levels resulted in an exponential decrease in collector current with neutron fluence at low current levels. Surface recombination had an insignificant effect on the collector-current characteristics. Postirradiation analysis indicated that the base current could be interpreted by considering neutron-induced recombination in the neutral base and in the emitter-base space-charge region. On the basis of calculated and experimental results obtained from both the reactor and the cobalt-60 irradiations, it was found that the surface component of the base current after reactor irradiation was negligible compared to the bulk components of base current. The dependence of common-emitter current gain, h_{FE}, on neutron fluence was evaluated from the analysis of the collector- and base-current characteristics. The increase in the reciprocal h_{FE} was a nonlinear function of neutron fluence, in contrast to the linear behavior that has been observed in vertical transistors. The dependence of collector-base voltage on h_{FE} could be described by a power-law expression both before and after irradiation. A study of the rate of gain degradation as a function of geometrical parameters showed that the thickness of the epitaxial layer, in addition to the base width, is important in determining the gain degradation. An equivalent-circuit model for the lateral pnp transistor was derived. The transistor model of the lateral pnp device can be used to evaluate the performance of linear IC's where radiation is another environmental factor. (Diss. Abstr. Int., B)

Miscellaneous Instruments and Components

Refer also to abstracts 23279, 23357–23358, 23391, 24987, and 25001.

22911 (ANCR-1046) CONDUCTIVITY-SENSITIVE LIQUID LEVEL DETECTOR FOR REACTOR ENVIRONMENT. Arave, A. E. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jan 1972. Contract AT(10-1)-1375. 16p. Dep. NTIS.

A conductivity-sensitive liquid level detector has been designed for the 200 to 1000°F, 2500 psi water environment of the Loss of Fluid Test (LOFT) reactor at the National Reactor Testing Station (NRTS). The detector is a ¼-inch diameter electrode surrounded by a cylindrical ground plane. By measurement of the electrical impedance between the electrode and the ground plane the presence of water can be detected. The success of the measurement depends upon a metal-to-ceramic seal that will withstand the environment outlined above. The metal-to-ceramic seal isolates the reactor environment from the signal cable dielectric and provides electrical isolation between the electrode and ground potential. The probe will be mounted inside a perforated support tube in the core region of the reactor. The electrodes will be spaced 3.5 inches apart over the length of the core. Testing the detectors in an autoclave at LOFT environmental conditions has shown the detection technique to work successfully. The signal-to-noise ratio is high allowing the instrumentation to be simple. There is a large impedance difference at the electrode between a steam and water media. (auth)

22912 (ANCR-1047) ULTRASONIC LIQUID LEVEL DETECTOR USING SURFACE WAVE ATTENUATION IN A TUBE. Arave, A. E. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jan 1972. Contract AT(10-1)-1375. 23p. Dep. NTIS.

The ultrasonic liquid level detector was developed for the 200 to 1000°F, 2500 psi corrosive water environment of the Loss of Fluid Test (LOFT) reactor at the National Reactor Testing Station (NRTS). The detector is a new concept in liquid level detection which isolates electrical signals from corrosive environments. The detector is the wall of a ½-inch diameter stainless steel tube. Attenuation of an ultrasonic surface wave as it propagates in the wall of the tube is a function of the water covering the tube. The magnetostrictive transducers for transmitting and receiving the ultrasonic signal are mounted axially in the tube and operate at 250 kHz in the burst mode. The detector is rugged and meets the tube configuration requirements for compatibility with the reactor core. Testing has shown the detector to be resistant to deterioration by the environment. The sensitivity to liquid level changes is good. But, the temperature sensitivity of the transducer causes the accuracy of the liquid level measurement to be worse than expected. A better design of the transducer and transducer-detector interface would eliminate this problem. (auth)

22913 (CEA-R-4276) RADIOFREQUENCY SPARK CHAMBERS AND DELAY-LINE RESONATORS. Sayag, G. Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 287p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France).

A spark chamber was excited by an undamped radiofrequency pulse and tracks about 1 mm wide were obtained; the result was interpreted by computation of the coefficients of electronic amplification and partial ambipolar diffusion. This work led to the construction of a new fast-triggering undamped wave-train generator of very high voltage (patent taken out by the C.E.A. under the n°: EN 7 134 650 the 27.9. 1971). Since this apparatus uses a resonant storage line, its design implies a precise knowledge of high-impedance delay lines. The experimental radiofrequency spectra of the input impedance of open- or short-circuited lines were plotted completely and analyzed by the circuit theory, and new measuring methods were established. Dispersion relations were accurately checked and the equivalence of the formulas, to third order, with those of Debye's Dipolar Absorption were demonstrated. General properties of Hilbert's transform were also investigated. From the experimental point of view, the electromagnetic energy storage process was extended to the case of a liquid-nitrogen-immersed resonant delay line. The good behavior of the cryogenic experiment where the main difficulty of icing was overcome by the construction of special electrodes, offers great promise for extrapolation to superconductivity. (67 figures, 3 tables, 12 plates) (auth)

22914 (GKSS-71/E/8) TEST OF A NEW STYLE HIGH-STANDING MEASURING EQUIPMENT FOR REACTOR PRESSURE VESSEL. Ottersbach, J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 32p. (In German). Dep. NTIS (U. S. Sales Only).

Based on a suggestion of the Fiat company, a water-level indicator was constructed with differential pressure-measuring cells. By means of an analog computer, the indicator corrects errors caused by ship motions and temperature changes. The indicator was tested under conditions that closely corresponded to operations of a ship reactor. During the testing, errors in the system were eliminated and, as far as possible, accuracy as well as dynamic behavior of the indicator was determined. (tr-auth)

22915 (NYO-3504-63) FIELD ION MICROSCOPE FOR THE MEASUREMENT OF THE FIELD IONIZATION CHARACTERISTICS OF INDIVIDUAL ATOMIC PLANES. Bohlen, James Winter (Cornell Univ., Ithaca, N. Y. Materials Science Center). Oct 1971. Contract AT(30-1)-3504. 45p. Dep. NTIS.

Thesis.

A newly designed field ion microscope system was constructed and tested. The capabilities of the new system are reviewed. The system was used to measure the current–voltage characteristics of a selected (111) tungsten surface plane at 91.7°K. A comparison of measured current–voltage characteristics to theoretically expected low-field behavior showed order-of-magnitude agreement for the characteristics and a slightly lower d(log i)/d(log v) than theoretically predicted. (11 figures) (auth)

22916 (UCRL-73460) LINEAR DISPLACEMENT TRANSDUCER FOR HIGH RATE MULTIPLEXING SYSTEMS. Peters, D. C. (California Univ., Livermore. Lawrence Livermore Lab.). Oct 1971. 13p. (CONF-711208-5). Dep. NTIS.

From Underground nuclear test measurements symposium; Albuquerque, N. Mex. (7 Dec 1971).

The design, fabrication, and principles of operation of this gage, basically a transformer, are described. The coupling between primary and secondary windings is controlled by inserting a copper vane in an air gap in the transformer. Eddy currents are produced in the copper which oppose the action of the flux in the air gap. The gage can resolve approximately 10 mils displacement in a travel of 2 cm taking 20 ms. Suggestions for improving the device are given. (6 figures) (R.W.R.)

22917 (UCRL-73568) VTAB: A PASSIVE IMPULSE GAGE. Comfort, W. J. (California Univ., Livermore. Lawrence Livermore Lab.). 24 Nov 1971. 11p. (CONF-711208-6). Dep. NTIS.

From Underground nuclear test measurements symposium; Albuquerque, N. Mex. (7 Dec 1971).

A passive gage was developed for impulse measurement in a nuclear environment. It can be designed to be unaffected by ground motion for typical amplitudes of 30 to 50 g. Design tradeoffs can be made to extend this level to 1,000 g or more, depending upon the sample and impulse levels to be measured. A single gage can be designed so that its measuring range is 15 to 20 times its threshold value. The configuration of the gage is a cantilever beam with a sample attached to the free end. The fixed end bends over a curved anvil of known radius. This arrangement serves two purposes: it defines the maximum strain in the beam so that the ultimate strain is not exceeded, and it causes plastic bending to occur over some distance rather than at a point. By increasing the width of the beam linearly, starting at the fixed end, the calibration curve of impulse versus angle of bend can be made nearly linear rather than having the parabolic shape characteristic of many passive impulse gages. An associated computer code, VTAB, is used to calculate design parameters for the gage and predict its response. (3 figures) (auth)

22918 FRINGING FIELD OF ELECTROSTATIC ANALYZERS. Bosi, G. (Univ. of Moncton, New Brunswick). Rev. Sci. Instrum.; 43: No. 3, 475-8(Mar 1972).

Several models of electrostatic mirrors are investigated; field distortions due to the entrance and exit slits are taken into account by carrying out exact solutions of the Laplace equation. The Dirichlet problems solved may be regarded as samples of a class of boundary value problems in a plane. The iterative method used enables contiguous solutions to be connected through a "broken" equipotential line. The results are presented in the form of recursion formulas allowing coefficients of a given order to be calculated as functions of lower order coefficients. (auth)

22919 NEW TIME-OF-FLIGHT MASS SPECTROMETER USING CHANNEL MULTIPLIERS AS ION SOURCE AND ION DETECTOR. Andresen, R. D.; Page, D. E. (European Space Research and Tech. Centre, Netherlands). Nucl. Instrum. Methods; 98: No. 3, 595-6(1972).

A new type of ion source is described which is especially suitable for time-of-flight mass spectrometers. Such an instrument seems to have some advantages when compared with commercially available residual gas analyzers. The fact that this new time-of-flight spectrometer consumes low power makes it attractive for space flight instrumentation. (auth)

22920 SMALL-SIGNAL IMPEDANCE OF p^+-i-n^+ DIODE UNDER HIGH-LEVEL INJECTION. Cheung, David K.-P. Columbus, Ohio; Ohio State Univ. (1971). 150p. University Microfilms Order No. 72-4447.

Thesis.

The injection of carriers into p-i-n diodes in the constant-voltage region and the region where the current density J_0 is proportional to the square of the diode voltage was studied. The constant-voltage region was related to a unity injection efficiency region in which the dc carrier densities (injected) are linearly proportional to the bias current. The $J_0 \sim V^2$ region was related to a nonunity injection efficiency region in which the heavily doped regions control the injection of carriers into the base (i-region). The expressions for the dc voltages of the diode were modified to give the small-signal ac voltages, and impedance models were constructed. The impedance of the diode is inductive for frequencies $w\tau$ (τ = recombination lifetime) less than unity in the case of unity dc injection efficiency. It can be inductive for frequencies $w\tau$ greater than unity in the case of nonunity injection efficiency. Expressions for the peak inductive Q factor (Q_m) and the frequency $w\tau_m$ at which this peak occurs were found from the impedance models. This inductive effect was attributed to the modulation of the dc drift resistivity and can be measured by a resistivity modulation factor $\tilde{M}\rho(x)$. This modulation comes from the perturbation of the dc drift field by the injected ac carriers. Diode voltage and impedance were evaluated using both a numerical solution and the models, and the results agree. The maximum value of Q_m increases exponentially with the increase of the base width-to-diffusion length ratio α. The dc injected density contains a deep minima when $\alpha > 1$. The maximum value of Q is limited by the maximum value of α acceptable for the high-level injection condition to hold. The maximum value of α for the case of unity injection efficiency is about 12, corresponding to a Q_m of 8. These figures agree with other published data. For the case of nonunity injection efficiency, the maximum value of α_m increases with bias current. For a realizable current of 100 A/cm^2, α_m is about 20, corresponding to a Q_m of 12. Experimental results were obtained from several diodes. Successive fast neutron bombardment was used to decrease the recombination lifetime of these diodes so that a wide range of α (α ranges from 0.8 to 8 using diodes with base widths ranging from 10 to 70 mils) has been obtained. These experimental results support the theoretical results. (Diss. Abstr. Int., B)

22921 TIME-RESOLVED SPARK-SOURCE MASS SPECTROMETRY: THE EFFECT OF SPARK DURATION ON ION INTENSITY AND PRECISION OF ANALYSIS. Franklin, James C. (Union Carbide Corp., Oak Ridge, Tenn.); Dean, John A. Anal. Lett.; 4: No. 12, 857-65(Dec 1971).

A radio-frequency probe and a synchronized electronic ion-beam chopper were used to determine ion-intensity variation with spark duration. Large peaks in multiply charged ion intensities are detected in the early stages of the radio-frequency spark, while later in the spark period the singly charged species predominate. The effects of these variations on the precision of analysis were determined. A gate was selected in the spark pulse, and a factor of two increase in precision was obtained. (auth)

22922 IMPROVEMENTS IN OR RELATING TO SEMICONDUCTIVE DEVICES. Lindmayer, Joseph (to Sprague Electric Co.). British Patent 1,261,365. 26 Jan 1972. Priority date 29 Apr 1968, United States.

A method is given for making an insulated gate field effect (MOS) transistor which has high radiation resistance. The method comprises the steps of forming a body of Si having a PN junction therein, forming an oxide coating over the junction, heating the coated body in a nonreactive atmosphere such as nitrogen above 400°C, depositing Cr over the coating, and reheating the body to cause the Cr to diffuse into the coating to form stable oxides. The high radiation hardness is due to the heating above 400°C which removes the incomplete bonds in the coating and readies the unit for stable bonding with diffused Cr. (D.L.C.)

22923 USE OF THE MULTICHANNEL ANALYZER FOR RECORDING THE SPIN-ECHO SIGNAL. Florkowski, Zdzislaw; Mielnicki, Andrzej; Ostrowicz, Andrzej (Inst. of Nuclear Physics, Krakow). Nukleonika; 16: No. 5-6, 243-50(1971).

A multichannel pulse analyzer was applied for digital recording of Carr-Purcell spin-echo sequence. Subsidiary circuits are presented. The testing measurements show advantages in sensitivity and accuracy of the presented method over the previously used registration techniques. (auth)

22924 GAS CHROMATOGRAPH-MASS SPECTROMETER-ACCELERATING VOLTAGE ALTERNATOR SYSTEM FOR THE MOLECULES. Klein, Peter D.; Haumann, Joseph R.; Eisler, William J. (Argonne National Lab., Ill.). Anal. Chem.; 44: No. 3, 490-3(Mar 1972).

A gas chromatograph-mass spectrometer with accelerating voltage alternation (GMA) for analysis of stable-isotope ratios in organic molecules is described. The system provides independent focusing for each mass, magnet stabilization, and sweep options and converts the output signal to digital form. The system shows excellent stability and can measure carbon isotopic ratios with an accuracy of 1 part in 10^4. (9 figures, 1 table) (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 22622 and 22690.

22925 (GAT-T-1748) ANALYSIS OF THE INTERDEPENDENCIES OF PARAMETERS AFFECTING THE COMPRESSOR EFFICIENCY UTILIZING THE SYSTEMS ENGINEERING APPROACH. Eilering, Leroy F. (Goodyear Atomic Corp., Piketon, Ohio). 28 Aug 1971. Contract AT(33-2)-1. 27p. Dep. NTIS.

Thesis. Submitted to Ohio Univ., Athens.

The gaseous diffusion process requires thousands of stages of separation to obtain the uranium enrichment desired. Therefore, even a small improvement in any one of the parameters affecting the converter and compressor performance can be utilized. Any improvement in the equipment reduces the resistance to flow of the gas stream which reduces the electrical consumption. The testing of the overall performance of the compressor and converter is very costly. If the interparametric relationships between the parameters affecting this overall performance were known, the testing of this equipment would be reduced to a minimum. This would result in a substantial economic savings over a period of time. One of these parameters, namely the compressor efficiency, and the other parameters affecting it were analyzed. The Systems Engineering Technique was used to perform this analysis. (auth)

22926 (ICP-1001) OPERATION OF THE ICPP RARE GAS RECOVERY FACILITY DURING FISCAL YEAR 1970. Bendixsen, C. L.; German, F. O. (Allied Chemical Corp., Idaho Falls, Idaho. Idaho Chemical Programs - Operations Office). Oct 1971. Contract AT(10-1)-1375. 23p. Dep. NTIS.

Operation of the Rare Gas Recovery Facility at the Idaho Chemical Processing Plant during FY 1970 resulted in the recovery of 10,432 curies and 1260 liters of krypton-85 and xenon, respectively, from off-gas produced during dissolution of spent nuclear fuel elements. Overall recovery efficiencies for krypton and xenon were 31 and 46%, respectively. Operation of a cryogenic distillation process with the potential efficiency of greater than 90% for krypton recovery was demonstrated. (auth)

22927 (KFK-1440) INVESTIGATION OF THE PATH OF FLOW OF He–Ar AND He–SF_6 MIXTURES IN THE SEPARATION NOZZLE WITH MOLECULAR FLOW TOWARD THE PRESSURE PROBE. Bier, K.; Brandtstaedter, H.; Ehrfeld, U.; Ehrfeld, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik. Technische Hochschule, Karlsruhe (West Germany)). Aug 1971. 57p. (In German). Dep. NTIS (U. S. Sales Only).

In connection with fundamental investigations of separation nozzle processes, an experimental technique has been developed for analyzing the local flow and diffusion phenomena in rarefied gaseous mixtures. The opening of a free molecular pressure probe, which is a thin tube with a side orifice, oriented successively at various angles to the flow direction, is used. The probe is connected directly to a mass spectrometer. From the angle dependence of the resulting ion currents, which are measured with the mass spectrometer, the flow direction, the local flux, and the speed ratio (i.e., the ratio of the stream velocity to the most probable velocity of thermal motion) can be determined for each component of the gas mixture. Results of such pressure probe measurements, which were made using He/Ar and He/SF_6 mixtures in the entire flow field of a large scale separation nozzle model, show that under economically optimum operating conditions of the separation nozzle process, the flow in the nozzle is highly viscous. Furthermore, considerable deviations from local thermal equilibrium occur throughout large regions of the flow: in this case the local velocity distribution function can be described by the superposition of two half-range Maxwellian terms. Results of the measurements also indicate that there is a velocity slip between the components of the mixture in some parts of the flow field. (auth)

22928 HIGH-TEMPERATURE ISOTOPIC THERMAL DIFFUSION OF NEON. Aurea Cunha, M.; Laranjeira, M. F. (Instituto Superior Tecnico, Lisbon). Physica; 57: No. 2, 306-16(15 Jan 1972).

Isotopic thermal diffusion factors have been determined for neon, in the temperature range 584 to 803°K. It is shown that the data are consistent with previous results at these temperatures and those at lower temperatures and also consistent with calculated second virial coefficient, transport phenomena, and with crystal data. The exponential-six model has been assumed for which the thermal diffusion data obtained provide realistic values of the parameter α. (auth)

22929 URANIUM ENRICHMENT. Sapirie, S. R. (Atomic Energy Commission, Oak Ridge, Tenn.). At. Jap.; 15: No. 3, 19-21(Mar 1971). (CONF-710344-2).

From fourth annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (15 Mar 1971).

The reasons for basing current operating programs and plans of the USAEC for near-term expansion of capacity solely on the use of the gaseous diffusion process are explained. Experience has shown that the process has had and continues to have many advantages. In 1940, Dr. J. Dunning proposed to do research on the gaseous diffusion process. But his proposal was turned down in favor of gas centrifuge proposal. Early work in the United States with the gas centrifuge for uranium isotope separation experienced difficulties due mainly to the complexity of design and lack of high-strength materials. At the same time, the electromagnetic process was selected for use in a first relatively large-scale separation plant, built at Oak Ridge and operated by some 22,000 workers. It can be described as cumbersome and inefficient. A plant employing the thermal diffusion process was built but did not operate efficiently. Meanwhile, the first gaseous diffusion plant was brought on stream in 1945. The process has proved to be stable and flexible in terms of varying assays and quantity of feed, tails, and product stream. As a result of development and testing, second generation plants have been substantially modified and improved. Research on the gas centrifuge was reopened in 1953. Accomplishments over next few years will be most important. (Japan)

22930 PROBLEMS ASSOCIATED WITH URANIUM ENRICHMENT IN JAPAN. Ipponmatsu, T. (Japan Atomic Power Co., Tokyo). At. Jap.; 15: No. 3, 29-31(Mar 1971). (CONF-710344-3).

From fourth annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (15 Mar 1971).

Since July 1969, JAIF has been discussing uranium enrichment with the Uranium Enrichment Committee, and last November it completed a Statement of Opinions. This states that a program should be adopted for an enriching plant of 5,000 tons SWU to go into operation before 1985. It also emphasizes that construction of a commercial-size plant should begin no later than 1980. Currently, there are two groups engaged in the R and D of centrifugal separation and gas diffusion in Japan. The statement points out the need for both techniques, not only with a continued support program, but also with promotion of this effort to such an extent that both groups can build fairly large scale plants, and conduct component proof-testing under as fully simulated operating conditions as possible. By this means it is hoped that evaluation will be possible by 1975 to enable selection of one or the other method. Then a pilot plant follows, and a full-scale plant will be guided by the outcome of this pilot program. Large numbers of components are required even at the pilot stage and expansion of facilities for producing the components is necessary. International cooperation will play an important role in the course of the development. There may be a need for Japan to improve its control system to protect the national interest. (Japan)

22931 URANIUM ENRICHMENT IN THE UNITED STATES. Sapirie, S. R. (Atomic Energy Commission, Oak Ridge, Tenn.). At. Jap.; 15: No. 3, 15-19(Mar 1971). (CONF-710344-4).

From fourth annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (15 Mar 1971).

Programs for expanding the capacity of gaseous diffusion plants in the U. S. are explained. Four potential sources of added capacity are given. These are: increased electric power usage in existing plants which is beginning to be exploited; the Cascade Improvement Program (CIP) for improving the existing equipment so as to incorporate advances in technology which improves power utilization efficiency and results in an increase of about 4,800 SWU at 6,100 NWe without any increase in power or other operating costs; the Cascade Uprating Program (CUP) to uprate the improved equipment where practicable to permit efficient utilization of more power which increases plant productivity by about 4,500 SWU with an increase of about 1,300 MWe above the present design limit of 6,100 MWe; and construction of new stages at existing sites or at new sites with a capacity of 8,750 SWU. New plant capacity will be required by about 1981 with the CIP and CUP. Without the CIP and CUP, new plant capacity would be needed at least two years earlier. A decision to build a new plant must be made about six years before it begins operation in order to contract for the electric power

required for operating the plant. The requirements, criteria, and actual price for enrichment services are discussed. (Japan)

22932 PROGRESS IN ULTRA CENTRIFUGE DEVELOPMENT IN THE NETHERLANDS. Bogaardt, M. (Ultra-Centrifuge Nederland, NV, The Hague). At. Jap.; 15: No. 3, 31-3(Mar 1971). (CONF-710344-5).

From fourth annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (15 Mar 1971).

The status of ultracentrifuge development in the Netherlands is described with special attention to the Almelo pilot plant. There are three steps in the development of a full-sized ultracentrifuge separation plant. The Almelo pilot plant represents result of the second step which is from the prototype cascade to a pilot plant. Construction was started in Nov. 1969. It is hoped that by the end of 1971, the first part of this installation will be started up. Final specific investment cost is estimated to be somewhat less than $50/kg SWU at present prices. Actual cascade cost can be reduced by factor of 4 and amounts to something less than $50. Thus, the total specific investment would amount to something like $100. It is expected that even fairly small ultracentrifuge separation plants of the order of only 500 to 600 tons may be competitive. Plants of 3,000 ton capacity or more might well be in a range to be aimed at in order to make full use of mass production of equipment. It has been argued on many occasions that one of the big uncertainties in the application of the ultracentrifuge method is the unreliability of the machines, and the rate of failure and replacement of such machines. It is considered that the yearly failure rate should be less than 2.5% in order for the ultracentrifuge method to be competitive. (Japan)

22933 GERMAN APPROACH TO URANIUM ENRICHMENT BY THE CENTRIFUGE PROCESS. Jelinek-Fink, P. (Uran-Isotopentrennungs GmbH, Juelich, Ger.). At. Jap.; 15: No. 3, 33-4(Mar 1971). (CONF-710344-6).

From fourth annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (15 Mar 1971).

The German effort in developing the centrifugal enrichment process is explained. Work in Germany on gas centrifuge for uranium enrichment was started during the war. The program was continued and the feasibility of centrifuge cascades of up to a stage at which industrial exploitation became possible, was demonstrated. A centrifuge pilot plant will be constructed at Almelo by the Enrichment Organization, shares of which are held by UCN, UKAEA, and URANIT. The prime contractor role is shared among UCN, UKAEA, and GnV. GnV and URANIT were founded in 1969 as private industrial companies and took over all German centrifuge work, including existing laboratories and personnel of the GKT. A prototype plant of German design with an annual capacity of 25 tons SWU will be erected in two stages at Almelo adjacent to a Dutch plant. Division into the two stages gives an opportunity to install, in the second stage, cascades and centrifuges of more advanced design utilizing progress made in the present R and D program. It will be progressively commissioned between March 1973 and Aug. 1974. Development work on the nozzle process is also in progress. Though the elementary separation effect of the nozzle process exceed that of the gaseous diffusion process by factor of 4 to 3, the specific power consumption is about two times larger than that of the diffusion process. (Japan)

Isotopic Power Sources

Refer also to abstracts 22697, 22783, 24726, 24923, and 25034.

22934 (AECL-3911, pp 27-34) ISOTOPE ENERGY SOURCE DEVELOPMENT AT COMMERCIAL PRODUCTS. Round, K. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

The radioisotope energy source program at the Commercial Products laboratories of Atomic Energy of Canada Limited comprises two project areas. The first and larger of these involves the design and development of cobalt-60-fueled thermoelectric generators capable of delivering several watts of electrical power for periods up to five years without maintenance. The second is an applied research study of energy conversion techniques for use in small isotope power systems commonly referred to as nuclear batteries. These devices are intended to deliver small amounts of electricity in the milliwatt or microwatt region for use in such applications as heart pacemakers. (auth) (Canada)

22935 (HIT-260) THE DESIGN AND FABRICATION OF SPHERICAL FUEL CAPSULES FOR RADIOISOTOPE GENERATORS. Final Report. (Hittman Associates, Inc., Baltimore, Md.). 30 Jun 1967. Contract AT(29-2)-2072. 184p. Dep. NTIS.

Declassified 2 Nov 1971.

Research and development directed to fabrication, assembly, and fueling of spherical fuel capsules is reported. Superalloy and refractory metal spherical capsules have been fabricated to required tolerances. Full penetration crack-free welds have been achieved. Provisions for fueling such capsules remotely in a hot cell have been incorporated in the design. The validity of these provisions has been demonstrated by loading and then sealing simulated fuel into these capsules. Two inch diameter capsule designs were selected to be constructed of a Haynes-25 inner liner and Haynes-25 outer case for applications to 1500°F, and a Ta-10W inner liner and a Haynes-25 outer case for applications to 1800°F. (J.R.D.)

22936 (MLM-1827) MOUND LABORATORY ISOTOPIC POWER FUELS PROGRAMS: APRIL-SEPTEMBER 1971. (Mound Lab., Miamisburg, Ohio). 14 Jan 1972. Contract AT(33-1)-Gen-53. 92p. Dep. NTIS.

Progress is reported on PuO_2-Mo cermet fuels development, diffusion of O in PuO_2, thermogravimetric determination of cermet stoichiometry, evaluation of Mo-coated cermet fuel disks, mobilities of powdered ThO_2 and PuO_2, and milliwatt generator loading. Other work is reported on compatibility testing of fuel capsules and fuels, and impact testing of fuel capsules. Results are also included on Min-K 1301 thermal insulation testing and compatibility of Ta with PuO_2-Mo cermets. (J.R.D.)

22937 ENERGY CONVERTER FOR PRODUCING A MECHANICAL OSCILLATION BY VIRTUE OF A TEMPERATURE DIFFERENCE. Van Andel, Eleonoor (to EURATOM). British Patent 1,266,073. 8 Mar 1972. Priority date 21 Jul 1969, Germany.

An energy converter is described which is suitable for use as an artificial heart for implantation. The converter operation depends on an oscillation obtained in a partially-filled upright tube closed at the top and open at the bottom containing an evaporable fluid exposed to a temperature gradient along the tube. The temperature at the upper end of the tube is above the vaporization point for the fluid at the start of the cycle. Under these conditions the meniscus rises to the point where vaporization takes place reversing the process. The cycle is repeated when the meniscus again forms at the lower end of the tube. A radioisotope heat source is provided to operate the mechanical oscillator. (J.R.D.)

Radiation Sources

Refer also to abstracts 22689, 22731, 23453, and 25034.

22938 BETA-BACKSCATTERING AND ABSORPTION COMBINED METHOD FOR MEASUREMENT AND CONTROL OF LIQUID CONCENTRATION. Das, S. K.; Pal, K. N. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri); 7: No. 4, 298-302(Oct-Dec 1970).

Measurement and control of liquid concentration with a high accuracy are discussed by a newly developed method based on the combined effect of absorption and backscattering of β-particles from $^{90}Sr-^{90}Y$ source. The resolving power of the process has been shown to be much higher than that of the earlier methods utilizing either absorption or backscattering of β-particles separately. Measurement of concentration of some ammonia compounds used as fertilizer is also discussed and a calibration curve is given for quick and efficient determination of percentage composition of ammonium sulfate and ammonium nitrate in the double salt. (auth)

22939 IMPROVEMENTS RELATING TO RADIATION SOURCES. (to Georgetown Univ.). British Patent 1,265,986. 8 Mar 1972. Priority date 30 Sep 1968, United States.

An electromagnetic radiation source is described in which an injection-type-junction superconducting device is operated below the transition temperature of the superconductor. The junction is formed by a normal metal, an oxide insulative film, and a superconductive material. The conductive point contact element forms a resonant cavity for maintaining standing waves of radiation and a conductive end surface. (J.R.D.)

22940 RADIOAKTIVNYE IZOTOPY V ELEKTRONNOI TEKHNIKE. (Radioactive Isotopes in the Electronic Industry). Vasil'ev, V. P. Moscow; Atomizdat (1971). 176p.

This monograph deals with the application of radioactive indicators and radiation in electronics. The accuracy of activity measurement, techniques in electrovacuum technology, the use

of radioisotopes in studying evaporation, diffusion, surface phenomena, and the physical chemistry of metal oxide cathodes are a few of the major topics discussed. Special types of electronic equipment and techniques includes gas discharge apparatus, cathode sputtering, and electron optics. A number of tables show the relative usefulness of specific isotopes in certain applications. (412 references.) (K.S.W.)

Design and Fabrication

22941 DEVICE FOR IRRADIATING THE BLOOD OF A PATIENT. Holmer, Arne Bernt Gustav (to Aktiebolaget Atomenergi). British Patent 1,266,242. 8 Mar 1972. Priority date 9 Oct 1968, Sweden.

The device is light enough by virtue of low-weight shielding that it can be carried by the patient. The design of the device is such that the radiation source is contained in shielding surrounding a tube through which the patient's blood flows. In this way the blood is irradiated while the patient's body is shielded. (J.R.D.)

Industrial Uses

Refer also to abstracts 23032–23033, 23049, and 23415.

22942 (AED-CONF-71-100-49) INVESTIGATION ON THE RADIATION TREATMENT OF FISH PRESERVES. Schoenborn, W.; Kinkel, H.-J.; Stahl, W. (Battelle Institut e. V., Frankfurt am Main (West Germany)). May 1971. 14p. (CONF-710901-535). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A study was made on the feasibility of using γ radiation processing for the preservation of vinegar-salt-spice marinades for pickled herring. Rats were fed irradiated (1600 and 4800 krad) marinade as 10 to 50% of their diet. No effects on behavior, reproductive capacity, or weight gain were observed over three generations. The economic aspects of using radiation processing for marinades were investigated, and it was concluded that the method was not feasible since radiation doses of over 160 krad made the product unpalatable. Herring in the 160 krad irradiated marinade had to be stored at temperatures of 12 to 16°C to prevent deterioration, and the cost of the irradiation equipment was high due to the seasonal nature of the fishing industry and the resulting utilization of the irradiation equipment for short time periods. (C.H.)

22943 (BFL-1/1970) CONSUMER TEST WITH IRRADIATED POTATOES. Gruenewald, Theo (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe (West Germany). Institut fuer Strahlentechnologie). May 1970. 47p. (In German).

A consumer test was carried out with potatoes irradiated for sprout inhibition with a dose of 12 krad γ radiation. The 34 participating families stored irradiated and unirradiated lots of potatoes in their homes. Throughout the storage period the consumers judged the outer appearance, the sprouting and rotting of the tubers, their suitability for different ways of preparation, and the organoleptic properties of the cooked product. The majority rated the irradiated potatoes as high as the untreated potatoes or higher than those. Part of the irradiated and unirradiated potatoes were stored for eight months and during this period evaluation of the potatoes prepared in different ways was carried out by a trained panel. Slightly lower scores were given to the irradiated potatoes, due to minor color deviation. The vitamin C content of the stored potatoes was determined repeatedly. In February and March higher values were obtained with the unirradiated potatoes and in April and May with the irradiated potatoes. (auth)

22944 (BFL-2/1971) WHOLESOMENESS OF IRRADIATED FOODSTUFFS. Papers of a Symposium held at Karlsruhe, 29 June–1 July 1971. Diehl, J. F. (ed.) (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe (West Germany)). Oct 1971. 81p. (In German and English). (CONF-710641).

Groups of papers are included on chemical changes in irradiated foods, toxicological and nutritional properties of irradiated foods, surveys of international irradiation programs, and microbiological aspects of food irradiation. (J.R.D.)

22945 (CONF-690459-1) WHOLESOMENESS OF IRRADIATED FOOD WITH SPECIAL REFERENCE TO WHEAT, POTATOES, AND ONIONS. Technical Report Series No. 451. (World Health Organization, Geneva (Switzerland)). 1970. 44p. INIS.

From Joint FAO/IAEA/WHO Expert Committee; Geneva, Switzerland (8 Apr 1969).

Wheat or ground wheat products were tested for wholesomeness, following irradiation using a maximum dose of 75,000 rad of γ radiation from ^{60}Co or ^{137}Cs, or electrons from electrical machines, the energy not exceeding 10 MeV. White potatoes irradiated with γ rays, using a maximum dose of 15,000 rad were also tested, as were onions. The purpose of irradiation was the control of insect infestation in the case of wheat, and to control sprouting of potatoes and onions during storage. Temporary acceptance was recommended for wheat and potatoes, in view of certain ambiguities in the results. No decision was possible on onions since a concentrated onion diet produced toxic effects in controls. (Active constituents in onions cause anaemia in most animal species.) Extensive studies on animals both short term (mouse, rat, chicken, pigeon, and dog) and long term (mouse, rat) fed on wheat or ground wheat products irradiated with doses up to 200,000 rad produced no evidence that irradiated wheat is toxic or carcinogenic. Rats, dogs, and pigs were used in short term studies with irradiated potatoes and onions, and rats in long term studies with irradiated potatoes. Details of further irradiation studies required, and a bibliography are given for wheat, potatoes, and onion. Data from nutritional studies are also given. (INIS)

22946 (COO-1592-36) IRRADIATION OF FRUITS AND VEGETABLES. Annual Report, April 16, 1968–July 15, 1970. Markakis, P.; Nicholas, R. C. (Michigan State Univ., East Lansing. Dept. of Food Science). Jul 1971. Contract AT(11-1)-1592. 52p. Dep. NTIS.

White mushrooms, which were treated to the average doses of 0, 12.5, 25, 50, and 100 krad of gamma irradiation, were tasted by a total of 85 judges, on days one, two, and seven following irradiation. The mushrooms were sauteed in butter prior to serving. No statistically significant differences in taste were detected among the five groups of mushrooms. The effect on shelf-life of white mushrooms after irradiation using ^{60}Co γ and 1-MeV-accelerated electrons at the levels of 12.5, 25, 50, 100, and 200 krad was determined. Gamma irradiation was more effective in inhibiting cap opening than electron irradiation at equal absorbed doses. It was also observed that if the electron beam was directed to the underside of the cap the inhibition of the opening was more pronounced than when the beam was directed to the top of the cap. White mushrooms intentionally bruised by free fall or by shaking either before or after 0, 25, and 100 krad of γ irradiation were visually compared by a total of 37 judges for brown discoloration. The comparisons which were made three and six days after irradiation showed that the irradiated mushrooms remained lighter in color during storage than the nonirradiated controls. (auth)

22947 (COO-2014-10) TWO-YEAR CHRONIC ORAL TOXICITY STUDY WITH LOW-DOSE IRRADIATED PAPAYAS IN BEAGLE DOGS. IBT No. C7042. Hartke, Kenneth (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 4 May 1971. Contract AT(11-1)-2014. 55p. Dep. NTIS.

No significant changes in body weight, food consumption, blood picture, blood chemistry, or reproductive capacity were observed in beagle dogs maintained for 21 months on a diet containing 15% radiation processed papayas when compared with controls. The papayas were γ-irradiated at 75,000 or 200,000 rads. (C.H.)

22948 (COO-2014-11) THREE-GENERATION REPRODUCTION STUDY WITH LOW DOSE IRRADIATED PAPAYAS IN ALBINO RATS. Second Generation. IBT No. B7041. Plank, James B. (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 10 May 1971. Contract AT(11-1)-2014. 21p. Dep. NTIS.

The results of a second generation study on the reproductive capacity of rats fed a diet containing low-dose γ radiation processed papayas showed that the number of pups delivered viable and the number retained at various points throughout lactation were normal for all groups. Survival indexes were essentially the same for treated and control progeny. The lactation index for the second litter of both test groups was slightly lower than the control. However, these indexes were within the normal range for the albino rat. The body weight data obtained at weaning disclosed no significant differences between test and control values. (C.H.)

22949 (COO-2014-12) THREE-GENERATION REPRODUCTION STUDY WITH LOW DOSE IRRADIATED PAPAYAS IN SWISS WHITE MICE. Second Generation. IBT No. P7040. Plank, James B. (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 10 May 1971. Contract AT(11-1)-2014. 23p. Dep. NTIS.

The results of a second generation study on the reproductive capacity of mice fed a diet containing low-dose γ radiation processed papayas showed that the number of pups delivered viable and the number retained at various points throughout lactation were essentially the same for all groups tested. No differences were noted between test and control animals with respect to survival or lactation indices. Body weight data obtained at weaning

revealed no significant differences between test and control values. (C.H.)

22950 (COO-2014-13) TWO-YEAR CHRONIC ORAL TOXICITY STUDY WITH LOW-DOSE IRRADIATED PAPAYAS IN BEAGLE DOGS. (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). 6 Jan 1972. Contract AT(11-1)-2014. 109p. Dep. NTIS.

No outstanding differences were observed between beagle dogs maintained during a two year period on a diet containing 15% radiation processed papayas and dogs fed non-irradiated papayas or control ration. The papayas were γ irradiated at 75,000 or 200,000 rads. Data are reported from studies on food consumption, behavioral reactions, mortality, blood picture, blood chemistry, urine analyses, reproductive capacity, pup survival, and litter weights. (C.H.)

22951 (KFK-tr-393) IRRADIATION OF FISH FROM THE SEA. Kardashev, A. V.; Bobrovskaya, N. D.; Golovkova, G. N.; Goftarsh, M. M.; Bukhteev, V. A. Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 79: 138-45(1971). 16p. (In German). Dep. NTIS (U. S. Sales Only).

Gamma radiation from a ^{137}Cs source was used for processing the following species of marine fish: Trachurus trachurus, Pagrus pagrus, Notothenia rossi, and Mocromesistius australis. A dose rate of 207 rad/sec was used and the capacity of the processing plant was 250 krad per 100 kg of fish. Radiation was carried out on board ship at sea. It was found that the use of 0.2 to 0.4 Mrad resulted in a good quality product with a shelf life increased up to 60 days at a temperature of 5°C. Changes in muscle proteins were insignificant and spoilage microorganisms were inactivated. (H.L.W.)

22952 (TID-25938(Vol.1)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: DOG STUDY. Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 184p. Dep. NTIS.

Data are presented on the body weight, organ weights, and reproductive capacity of dogs maintained on a diet that included 35% low-dose γ-irradiated strawberries. No remarkable differences were found in the test group and control group. Differences in body weight were attributed to diet acceptability rather than to radiation effects. (C.H.)

22953 (TID-25938(Vol.2)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: RAT STUDY. Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 120p. Dep. NTIS.

Data are presented on the body weight, organ weight, reproductive capacity, and other clinical parameters of rats maintained during four generations on a diet that included 35% low-dose γ-irradiated strawberries. No differences attributable to the diet were found in test and control groups. (C.H.)

22954 (TID-25938(Vol.3)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: RAT STUDY (REPLICATE 1). Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 218p. Dep. NTIS.

Clinical data are presented on rats maintained during four generations on a diet that included 35% low-dose γ-irradiated strawberries. (C.H.)

22955 (TID-25938(Vol.4)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: RAT STUDY (REPLICATE 1). Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 207p. Dep. NTIS.

Data obtained at autopsy of rats that died or were sacrificed at various times while being maintained on a diet that included 35% low-dose γ-irradiated strawberries are presented. Data are included on four generations. (C.H.)

22956 (TID-25938(Vol.5)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: RAT STUDY (REPLICATE 2). Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 218p. Dep. NTIS.

Clinical data are presented on rats maintained over four generations on a diet that included 35% low-dose γ-irradiated strawberries. No remarkable differences related to diet were observed in the test group when compared with the control group. (C.H.)

22957 (TID-25938(Vol.6)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: RAT STUDY (REPLICATE 2). Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 215p. Dep. NTIS.

Data obtained at autopsy of rats that died or were sacrificed at various times while being maintained on a diet that included 35% low-dose γ-irradiated strawberries are presented. Data on four generations of rats are included. (C.H.)

22958 (TID-25938(Vol.7)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: CHICKEN STUDY. Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 132p. Dep. NTIS.

Data are presented on the body weight, organ weights, egg production, and autopsy findings of chickens maintained on a diet that included 35% low-dose γ-irradiated strawberries. Data are included on four generations. No remarkable differences were found in test groups and the control group. (C.H.)

22959 (TID-25938(Vol.8)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: CHICKEN STUDY. Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 199p. Dep. NTIS.

Data are presented on the body weight, organ weights, egg production, and clinical parameters of chickens maintained on diet that included 35% low-dose γ-irradiated strawberries. Data on four generations are included. (C.H.)

22960 (TID-25938(Vol.9)) CHRONIC TOXICITY STUDIES ON IRRADIATED STRAWBERRIES: CHICKEN STUDY. Nees, Paul O. (Wisconsin Alumni Research Foundation, Madison). [nd]. Contract AT(11-1)-1722. 269p. Dep. NTIS.

Data obtained at autopsy of chickens that died or were sacrificed at various times while being maintained on a diet that included 35% low-dose γ-irradiated strawberries are presented. Data on four generations are included. (C.H.)

22961 EFFECT OF γ-IRRADIATED ROAST BEEF ON ALBINO RATS. Kamal'dinova, Z. M. Vop. Pitan.; 29: No. 2, 73-7 (1970). (In Russian).

Pieces of beef were roasted in an infrared oven, vacuum packed in cellophane polyethylene film, and irradiated at 0.8 Mrad using a ^{60}Co γ source (rate, 800 R/sec). Irradiated meat was organoleptically indistinguishable from non-irradiated control meat. In general, there was little difference in the performance of rats fed irradiated beef to that of controls but, from the higher level of tributyrinase in the livers of rats and their lower urinary excretion of riboflavin, it was concluded that irradiation caused some untoward changes in the meat, and roast beef irradiated at 0.8 Mrad is not recommended for human consumption. (Euratom)

22962 OSTEOSYNTHESIS BY PRESERVED TRANSPLANTS EXPOSED TO GAMMA RADIATION. Gashimov, R. R. Azerb. Med. Zh.; 48: No. 5, 24-8(1971). (In Russian).

A clinical investigation was made of the possibility of effecting tissue transplants that were stored at -70°C, sterilized by gamma radiation, and stored in plastic for three months. Anesthetized rabbits were operated on so as to lay bare the shaft of the right foreleg, and a resection of the radial bone was performed. For 12 rabbits thus treated, bone transplants were accomplished after -70°C storage of the tissue; six of the 12 transplants were sterilized with gamma radiation following cold storage. The animals were carefully observed for three months after transplants, then examined by x-ray photographs for tissue restoration in the radial bone. The results showed that bone material can be preserved at -70°C for 20 days, then maintained in plastic for 2 to 3 months at room temperature, without losing its biological activity and its ability to function in the healing process. Gamma radiation successfully sterilized preserved transplants. (K.S.W.)

22963 QUANTITATIVE AND QUALITATIVE CHANGES IN RAW PROTEINS IN A RAT AND MOUSE DIET BY MEANS OF VARIOUS STERILIZATION PROCEDURES. Udes, H.; Hiller, H. H.; Juhr, N. C. (Institut fuer Versuchstierkunde und Versuchstierkrankheiten, Berlin). Z. Versuchstierk.; 13: 160-6 (1971). (In German).

An appropriate standard breeding diet for rats and mice was tested in respect to any alterations in the quantity and quality of the crude protein due to sterilization by steam, ethylene oxide, or γ irradiation. Steam sterilization at 134°C for 20 min led to a loss of about 8% in crude protein content. In particular the following amino acids were affected: lysine, methionine, cysteine, isoleucine, arginine, and leucine. Treatment with ethylene oxide did not lead to sterilization of the diet. Irradiation at 2.5, 5, and 10 Mrad did not lead to any appreciable changes in the quantity and quality of the protein in the diet. Irradiation appeared to be the preferred method of sterilization. Irradiation at 2.5 Mrad appeared to be adequate to ensure sterilization of the standard diet. (auth)

22964 INFLUENCE OF GAMMA RADIATION ON THE CARBOHYDRATE FRACTION OF RYE. Horubala, A.; Szpryn-

ger, M. (Szkola Glowna Gospodarstwa Wiejskiego, Warsaw). Rocz. Technol. Chem. Zywn.; 20: 43-50(1971). (In Polish).

Rye grain irradiated with 2×10^4 to 10^5 rad doses of gamma radiation does not display essential changes in its carbohydrate fraction, measured by the content of starch, dextrin, and the directly reducing sugars, maltose, glucose, xylose, and arabinose. The doses from 5×10^5 to 3×10^6 rad caused a reduction in starch content by 8 to 10%, an increase by 100% in the content of dextrins, by about 50% in the content of directly reducing sugars and an increase up to 100% in the content of arabinose and xylose. The radiation doses of the order of 5×10^5 to 3×10^6 rad caused a rapid reduction of the amylographic viscosity of flour—which was about 30% for a control sample, for the 5×10^5 dose, with a further reduction of about 80% for the highest dose. Also the viscosity of the extracted rye mucus decreased more than 10 times. Visible changes in flour coloration were observed where doses of 5×10^5 rad and more were applied. (auth) (INIS)

22965 TABLE OF SELECTED PHYSICAL CHARACTERISTICS OF SOME RADIONUCLIDES USED IN MEDICINE. Husak, Vaclav (Univ. Hospital, Olomouc, Czech.). Jad. Energ.; 17: No. 11, 384-90(Nov 1971). (In Czech).

A new concept for a table of physical characteristics of radionuclides used in medicine and biology is suggested. The table contains half-life data and decay modes of radionuclides, absorbed dose constants for penetrating and nonpenetrating radiations, and specific gamma ray constants. New methods for calculating the absorbed dose from radiopharmaceuticals used in medicine are explained. (auth)

22966 RADIATION INDUCED ALTERATIONS IN FLAVOR COMPONENTS IN PENEAUS SETIFERUS. Ismail, Raja Jaffan. Baton Rouge, La.; Louisiana State Univ. and A and M Coll. (1971). 110p. University Microfilms Order No. 71-29,374.

Thesis.

Flavor components in Peneaus setiferus and their alterations during γ radiation and subsequent refrigerated storage were investigated. The quality of iced-stored shrimp was influenced by lipid deterioration which is a result of the reactivity of its characteristic fatty acids. The fatty acid composition and the nature of volatile carbonyls was investigated in fresh, irradiated, fresh iced-stored, and irradiated iced-stored shrimp. Moreover, if the product is irradiated, carbonyls are formed from the radiation induced oxidative chain action on fatty acids. In the samples used, the amount of total lipids extracted per 100 g shrimp ranged from 0.7 to 0.8 g. Fatty acids identified from lipid extracts by gas-liquid chromatography in both the non-irradiated and the irradiated samples were: myristic, myristoleic, pentadecanoic, palmitic, palmitoleic, stearic, oleic, linoleic, and linolenic. Palmitic and oleic acids were predominant in every sample. The predicted radioinduced decrease in fatty acids was not observed in the fatty acids identified. The results indicated that storage of both irradiated and non-irradiated shrimp had very little effects on the fatty acid composition of the samples. Concentration of identified carbonyls in non-irradiated iced-stored shrimp increased throughout 21 days storage, and then tended to fall off. However, hexanal and 2-butanone showed less increase in the peak height than the other compounds investigated. Samples irradiated at a dose of 0.15 Mrad showed stable carbonyl compounds during a storage period of 21 days, but resulted in a slight increase after 30 days. The radioinduced immediate increase in carbonyl concentrations in the iced-stored irradiated shrimp at 0.8 Mrad appeared to continue during the first seven days, and then tended to decrease. (Diss. Abstr. Int., B)

22967 RADIATION PRESERVATION OF TROPICAL SHRIMP FOR AMBIENT TEMPERATURE STORAGE. 1. DEVELOPMENT OF A HEAT-RADIATION COMBINATION PROCESS. Savagaon, K. A.; Venugopal, V.; Kamat, S. V.; Kumta, U. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). J. Food Sci.; 37: No. 1, 148-50(Jan-Feb 1972).

A process employing heat and low-dose gamma radiation for stabilizing tropical shrimp for room temperature storage is discussed. Results of experiments where shrimp were cooked for 8 min at 121°C, packaged in flexible pouches, irradiated to a dose of 100 Krad, and stored at room temperature indicated that the process would preserve the shrimp for 6 to 8 weeks. (T.F.D.)

22968 RADIATION PRESERVATION OF TROPICAL SHRIMP FOR AMBIENT TEMPERATURE STORAGE. 2. STORAGE STUDIES. Savagaon, K. A.; Venugopal, V.; Kamat, S. V.; Kumta, U. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). J. Food Sci.; 37: No. 1, 151-3(Jan-Feb 1972).

The quality of shrimp during storage after being processed by a heat-radiation method was studied. The method consisted of cooking for 8 min at 121°C, packaging in flexible pouches, and irradiating with gamma radiation to a dose of 100 Krad. Chemical quality indexes such as trimethylamine, thiobarbituric acid, total volatile basic nitrogen, and peroxides were determined. Effects of processing and storage on total and free amino acids and some of the water soluble vitamins were also studied. The product had an acceptable storage life of 6 to 8 weeks. (T.F.D.)

22969 MARKING CONSUMER ITEMS BY RENDERING COLORLESS MARKINGS PERMANENTLY COLORED WITH RADIATION EXPOSURE. Hughes, Burton B. U. S. Patent 3,639,762. 1 Feb 1972. Filed 14 Feb 1969.

Consumer items are marked with two or more colorless markings each of which can be rendered colored by exposure to different levels of radiation. Exposure to one level of radiation selectively changes one marking to a substantially permanently colored, visible state without affecting the colorless state of the other markings. (Official Gazette)

22970 CONVEYOR SYSTEM FOR THE UNIFORM EXPOSURE OF ARTICLES OR MATERIALS TO A SOURCE OF GAMMA OR THE LIKE RADIATION. Armel, Jack; Kogan, Mark; Cohen, Howard S. (to TSO Nuclear Corp.). U. S. Patent 3,641,342. 8 Feb 1972. Filed 3 Nov 1969.

A known or fixed source of radiation, such as gamma radiation, is described for use in an automatic conveyor system for plural-like unitary containers laden with articles or materials to be subjected to controlled radiation exposure. The system accommodates a number of containers at all times, and uniform exposure is achieved for the contents of each container by having all containers follow precisely the same pattern or locus of movement through the system, and with respect to the source. Container movement is accomplished by indexing operations, performed simultaneously on all containers; the desired exposure time is governed by selection of dwell time between indexes, so that a single indexing cycle may serve the system regardless of the selected exposure time. (Official Gazette)

22971 POSSIBLE USE OF GAMMA RADIATION IN WASTE WATER TREATMENT. Ramakrishnan, C. V. (Baroda Univ., India). J. Sci. Ind. Res.; 30: No. 5, 228-34(May 1971).

Safeguarding food supplies and water from microbial and other contamination is an important public health problem as such contamination accounts for the widespread incidence of infections and parasitic infestations. The problem of purifying domestic waste is further complicated by the addition of industrial waste which often has the effect of retarding the natural process of purification. The use of gamma irradiation may help to solve this problem to a considerable extent, especially in developing countries. Gamma irradition was found to be effective in the treatment of domestic waste as well as industrial waste. It did not inhibit the growth of algae, which are important for the purification of sewage. (auth)

LIFE SCIENCES

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 22985, 22989, 23007–23009, 23012, 23030, 23043, 23086, and 23100.

22972 (KURRI-TR-84, pp 21-5) DARK RECOVERY ENZYME OF MICROCOCCUS LYSODEIKTICUS (LUTEUS). Okubo, Shunzo; Nakayama, Hiroaki (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

In the extracted fluid of Micrococcus lysodeikticus, there is an endonuclease (hereafter shall be called uv-endonuclease) that acts specifically on DNA irradiated with ultraviolet radiation (uv). The nature of this enzyme was studied after purifying the fluid about 730 times by chromatography and isoelectric focussing. UV-endoclease produces single-strand breaks that correspond to the number of dimers after acting on DNA irradiated with uv. The enzyme purified by the present authors acts also on modified DNA irradiated with uv. The result did not coincide with what was reported by Kaplan et. al. and Carrier and Setlow. The molecular weight of the enzyme is about 13,000. In order to know whether the uv-endonuclease is the first enzyme of dark recovery or not, correspondence between repair process in vivo (single-strand breaks, excision of dimers, and collapse of DNA) and enzymatic activity in vitro were sought for by separating uv-sensitive mutation product and uv-endonuclease-less mutation from M. lysodeikticus. It was known that in crude extracted fluid, mutation product without uv-endonuclease activity (uv-resistant transformant of 1312 and G_7 origin) is resistant against uv and moreover, the single-strand breaks by uv irradiation in vivo occur in the same way with that of the wild type. That is, there was no evidence of correspondence between single-strand breaks in vivo and uv-endonuclease activity. However, in two mutation products, it became known that rejoining of dimer cuts or single-strand breaks makes slower progress than the wild type. In view of these results, uv-endonuclease seemed to be acting secondarily on dimer cuts in vivo. (Japan)

22973 (ORO-3631-3) RADIATION BIOPHYSICAL STUDY OF BIOLOGICAL MOLECULES. Progress Report, September 1, 1970–January 31, 1972. Fluke, Donald J. (Duke Univ., Durham, N. C.). Contract AT(40-1)-3631. 5p. Dep. NTIS.

Progress is reported on research in the following areas: temperature dependence of radiation effects on solubility and substrate kinetics of hyaluronidase and lactate dehydrogenase (LDH); activation energies and direct action temperature dependence of hyaluronidase and LDH; effects of ultraviolet radiation on induction of fluorescence in LDH and NADH; effects of temperature on uv-induced absorbance of mylar; temperature dependence of the direct action for fast electron irradiation of trypsin, lysozyme, ribonuclease, hyaluronidase, LDH, xanthine oxidase, papain, and T1 phage; and RBE for effects of protons and gamma radiation on T1 phage. (H.L.W.)

22974 (TID-25916) ELECTRON MICROSCOPIC STUDIES ON THE SUBSTRATE SPECIFICITY OF THE T4 EXCISION REPAIR ENDONUCLEASE. Friedberg, Errol C.; Clayton, David A. (Stanford Univ., Calif. Dept. of Pathology). [1971]. Contract AT(04-3)-326. 8p. Dep. NTIS.

SV40 DNA was obtained by extraction of purified virus isolated from infected green monkey kidney cells and was shown by electron microscopy and sedimentation analysis to consist of about 90% supercoiled molecules and 10% open circles. The DNA was uv-irradiated at a dose rate of 8 ergs/mm²/sec. A technique is described that gives extreme sensitivity for the detection of phosphodiester bond scissions in DNA and also allows determination of the pyrimidine dimer content of uv-irradiated DNA by a totally independent method that does not require radioactive labeling. The procedure involves the differentiation of supercoiled circular DNA from relaxed circular DNA by electron microscope examination. This technique provides the required sensitivity for examination of the substrate specificity of the T4 excision repair endonuclease. By measuring the relative frequency of supercoiled and relaxed circles following enzymatic incubation of SV40 DNA uv-irradiated at very low doses, it was possible to demonstrate a Poisson distribution of dimers, thereby allowing a direct determination of the average dimer content of the DNA. (H.L.W.)

22975 CHANGE OF THE ANTIGENICITY OF THE PROTEINS, UNDER THE EFFECT OF IRRADIATION. I. THE CHANGE OF ANTIGENICITY OF THE HUMAN SERUM-ALBUMIN, AFTER IRRADIATION IN THE AIR AND IN OXYGEN. Miltenyi, Laszlo; Vargha, Gyula; Dezsi, Zoltan. Magy. Radiol.; 23: No. 6, 337-40(Dec 1971). (In Hungarian).

The change of the antigenicity of the human serum albumin after irradiation has been examined. The simple immunodiffusion method is suitable for the demonstration of small changes. The deviation increases proportional to the dose, and it gives appreciable results even in the case of relatively small doses. After saturation with 100% of oxygen and using dissolved human serum-albumin the radiation effect increases by one order of magnitude. (auth)

22976 EFFECT OF $^{22}Na^{+}$ ON A PHOSPHOLIPID MEMBRANE. Petkau, A. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Health Phys.; 22: No. 3, 239-44(Mar 1972).

Radioactive $^{22}Na^{+}$ was used to irradiate model phospholipid membranes. It was found that the membranes rupture after irradiation periods varying from 20 to 600 min, depending on the dose rate. It was further found that both the membrane duration and the absorbed dose at which the membrane ruptured could be correlated with the dose rate by both power and exponential functions. The phenomenon is discussed on the basis of radiation-initiated oxidation and polymerization reactions. (auth) (UK)

22977 EFFECTS OF γ-RADIATION ON CONCENTRATED SOLUTIONS OF α-CHYMOTRYPSIN. Lynn, K. R. (National Research Council of Canada, Ottawa). Radiat. Res.; 49: No. 1, 51-62(Jan 1972).

Chymotrypsin as a 10^{-3}M solution in dilute HCl was irradiated with ^{60}Co under air and nitrogen. Esterolytic and proteolytic activities were measured with synthetic and natural substrates, non-exponential dose/activity relationships being found for the latter. Losses of activity by the enzyme were attributed to significant conformational shifts, in part caused by demonstrated destruction of some tryptophan residues. Comparison of the results from this work with those obtained in studies with dilute solutions of the enzyme showed that minor conformational changes which occurred on dimerization of chymotrypsin did not qualitatively affect the radiation damage to the enzyme. (auth)

22978 INTERACTIONS OF 25 keV ELECTRONS WITH GUANINE AND CYTOSINE. Johnson, Dale E. (Univ. of Chicago). Radiat. Res.; 49: No. 1, 63-84(Jan 1972).

The energy loss spectra of 25 keV electrons passing through thin condensed films of the nucleic acid bases quanine and cytosine have been measured over the range of energy losses from 0 to 500 eV. Transitions from π and σ molecular orbital levels and atomic K levels to bound excited states of the molecules as well as ionizations were observed. Cross sections for these energy loss processes and also cross sections for damage of the molecules by the electron beam are given. By describing the energy loss spectra in terms of the dielectric theory, the optical constants for these materials are calculated and used in interpretation of the energy loss mechanisms. (auth)

22979 RADICAL OXIDATION MECHANISMS IN CELLULAR RADIOSENSITISATION: ELECTRON TRANSFER IN THE PULSE RADIOLYSIS OF AQUEOUS NUCLEOTIDE SOLUTIONS. Adams, G. E.; Greenstock, C. L.; van Hemmen, J. J.; Willson, R. L. (Mount Vernon Hospital, Middlesex, Eng.). Radiat. Res.; 49: No. 1, 85-95(Jan 1972).

Pulse radiolysis has been used to study one-electron transfer reactions in aqueous solutions containing various nucleic acid derivatives and, also, in solutions containing some highly electron-affinic compounds which can function as cellular radiosensitizers. These include two methyl naphthaquinone and paranitroacetophenone (PNAP). Radicals derived from nucleic acid derivatives transfer electrons to the sensitizers at rates which approach diffusion-limited values. The electron affinity of the substituted pyrimidine, orotic acid (OA) is intermediate between those of the common nucleic acid derivatives and those of the radiosensitizers. This, together with the intense absorption spectrum of its electron adduct, makes it a useful marker for these studies. The relevance of these model studies in aqueous solution to mechanisms of radiosensitization, is discussed. (auth)

22980 CURRENT TOPICS IN RADIATION RESEARCH. VOLUME VI. Ebert, Michael; Howard, Alma (ed.). New York; John Wiley and Sons, Inc. (1970). 422p.

Separate abstracts were prepared for the seven review articles presented in this publication. (E.R.B.)

For abstracts of individual papers see: 22632, 22992–22993, 23025, 23066, 23087, and 23114.

22981 SOME SITES FOR THE INDIRECT EFFECTS OF RADIATION ON DNA CONSTITUENTS. Singh, B. B.; Srinivasan, V. T.; Mishra, K. P.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Trombay, India). pp 73-80 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

Among the various types of radiation-induced DNA damages, single-strand and double-strand breaks and their genetic consequences have been extensively investigated in recent years. The nature of base damage, however, remains comparatively overlooked although high rates of reaction of bases with the radiolytic products of water have been demonstrated. Whereas hydroxyl radicals and hydrogen atoms add to purine and pyrimidine rings giving rise to corresponding radicals, reaction of bases with radiation-induced electrons leads to the formation of base anions which under suitable environmental conditions become hydrolyzed to yield neutral radicals. The addition of sugar and sugar phosphate residues to the bases was found to affect the yields of anions and radicals of bases and the results could not suggest the breakage of the sugar-phosphate and sugar-base bonds as was shown earlier for the direct effects of radiation. The genetic implications of these types of base damages need careful consideration. (auth)

22982 MEASUREMENT OF PLASMA ANGIOTENSINASE ACTIVITY BY A RADIOIMMUNOASSAY METHOD. Strong, Cameron G.; Tapia, Hugo R.; Walker, V. Ray; Hunt, James C. (Mayo Clinic, Rochester, Minn. Mayo Foundation, Rochester, Minn.). J. Lab. Clin. Med.; 79: No. 1, 170-80(Jan 1972).

A modified angiotensin 1 radioimmunoassay method has been developed for the determination of plasma angiotensinase activity (PAA). Three nanograms of synthetic isoleucine-5-angiotensin 1 were incubated with 0.5 ml of undiluted plasma at 37°C, pH 7.4, in the presence of an inhibitor of converting enzyme (3×10^{-3}M bipyridine). Undegraded angiotensin 1 was measured in triplicate 0.1 ml aliquots of the incubation mixture by radioimmunoassay. The coefficient of variability with this method was 12.97%. The maximal velocity of the PAA reaction occurred at 10 minutes of incubation. PAA was not significantly different in men and women; for the combined group of normal subjects, PAA was 4.21 ± 1.3% (mean ±1 S.D.) degradation of angiotensin 1 per minute. (auth)

22983 CORRELATION OF STRUCTURAL ALTERATIONS IN BOVINE FIBRINOGEN WITH LOSS OF CLOTTING PROPERTIES AFTER GAMMA IRRADIATION. Kamat, Hemalata N.; Nadkarni, G. B. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Res.; 49: No. 2, 381-9(Feb 1972).

The effect of gamma irradiation on aqueous solutions of purified bovine fibrinogen has been assessed with reference to clotting properties and physico-chemical changes in the protein. The radiation-induced loss in clottability could be correlated with the unfolding of the protein through cleavage of disulfide linkages. The reconstitution of these bonds could bring about restoration of clotting properties to some extent. The dose-response (0 to 500 kR) showed initial polymerization and subsequent disintegration of the protein with the formation of insoluble aggregates. An analysis of these revealed that cysteine and methionine residues were oxidized to cysteic acid and methionine sulfone, respectively, at higher doses. The presence of larger amounts of arginine in the aggregates indicated that the precipitation by irradiation was not accompanied by liberation of peptides in the soluble phase, normally observed during the clot formation by action of thrombin. The results show that structural identity of fibrinogen determines its functional integrity as substrate of thrombin. (auth)

22984 LIMITATIONS TO SIGNIFICANT INFORMATION IN BIOLOGICAL ELECTRON MICROSCOPY AS A RESULT OF RADIATION DAMAGE. Glaeser, Robert M. (Univ. of California, Berkeley). J. Ultrastruct. Res.; 36: 466-82(1971).

Quantitative measurements of radiation damage in crystalline specimens of l-valine, adenosine, and catalase (uranyl acetate stained) were made by observing the loss of the electron diffraction pattern. Reciprocity of specimen lifetime and current density at the specimen demonstrates the absence of any dose-rate effect, such as specimen heating, as a cause of specimen damage within the range 10^{-9} to 10^{-5} amperes/cm^2 current density at the specimen. Specimen lifetimes at high voltages are about two and a half times greater than at conventional voltages, and it is shown that this is consistent with the dependence of linear energy loss upon accelerating voltage. The limiting resolution for meaningful observation is considered in terms of the statistics of observation at particle fluxes that are specified from the specimen lifetime data. The best values are probably not better than 50 Å for l-valine, 20 Å for adenosine, and 15 Å for catalase. (auth)

Radiation Effects on Cultured Cells (External Source)

Refer also to abstracts 22980 and 23058.

22985 (KURRI-TR-84) REPORTS OF THE STUDY MEETING ON RECOVERY OF RADIATION INJURIES, OSAKA, JAPAN, AUGUST 4, 1970. Takebe, Hiraku; Akaboshi, Mitsuhiko (eds.) (Kyoto Univ. (Japan). Research Reactor Inst.). 1971. 77p. (In Japanese and English). (CONF-700854). NTIS (U. S. Sales Only).

Separate abstracts were prepared for the 11 papers presented at this conference. (E.R.B.)

For abstracts of individual papers see: 22972, 22986–22987, 23007–23011, 23035, 23051, and 23057.

22986 (KURRI-TR-84, pp 36-45) RECOVERY OF SINGLE-STRAND BREAKS OF DNA IN CULTURED CELLS. Sawada, Shozo; Okada, Shigefumi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

When cultured leukemia cell L5178Y is irradiated with x ray, single-strand breaks of DNA occur. And following this, these broken single-strands of DNA rejoin within the cell. Characteristics of the rejoining process were studied. The speed of rejoining was measured as the exponential decrease of the number of breaks, and it changes depending upon the radiation doses. Also, the speed coincides with what was obtained by changing the dose rate. The rejoining speed changes according to the temperature, but in cellular cycles, the change is small. As for the effect of drugs, cysteamine and cystamine retard the rejoining speed. With these results, various other recovering phenomena in cells irradiated by x ray were compared. (Japan)

22987 (KURRI-TR-84, pp 46-52) RELATIONSHIP BETWEEN IRRADIATED GENERATION AND CELL. Sasaki, Hiroshi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

The relation between irradiated generation and cell death, and the forming process of the colony were studied by preparing genealogical trees of each individual cell after tracing for a long period HeLa S_3 cells that were irradiated with x rays or fast neutron-beams by microscopic cinematograph (16 mm) or photograph (35 mm). Retardation of cellular division is remarkable in the irradiated generation, and in the next generation the situation became almost normal. Cell fusion occurs in rather high frequency and binuclear cells produced by the fusion become impossible to divide. The fusion occurs mainly among daughter cells, and on a rare occasion, among cousin cells. Among the cells that do not divide for rather long periods (more than 100 hrs), there are some that become monstrous and some that do not. In the process of forming colonies, lethal sectoring that is recognized in yeast seems to be working. (Japan)

22988 EFFECT OF RADIATION UPON LYMPHOCYTE RESPONSE TO PHA. Rickinson, A. B.; Ilbery, P. L. T. (Univ. of Sydney). Cell Tissue Kinet.; 4: No. 6, 549-62(Nov 1971).

The proliferative response of lymphocytes to phytohaemagglutinin has been studied following incremental doses of ^{60}Co gamma radiation delivered at the beginning of culture. A dose-dependent inhibition of ^{3}H-thymidine uptake is apparent in 48 hr and 72 hr cultures throughout the 250-2000 rad range, and the effect appears more marked at the later labelling time. Parallel autoradiographic studies have revealed changes in the cell cycle kinetics of irradiated cultures which underlie the effects observed at the whole-culture level. Irradiation reduces the number of cells reaching the first period of DNA synthesis and causes dose-dependent delays at specific points in the cycle of proliferating cells. (auth)

22989 METABOLIC SIGNIFICANCE OF CHANGES IN REDUCED GLUTATHIONE CONTENT IN "IN VITRO" IRRADIATED HUMAN RED CELLS. Mombelli, Luigi; Fidanza, Mariangela; Favaro, Luigi; Porro, Roberto Crespi (Univ., Milan). Radiol. Med.; 57: No. 3, 201-9(Mar 1971). (In Italian).

Reduced glutathione, ^{14}C-glycine uptake, glutathione-reductase, and ATP values were determined in human red cells following single-dose irradiation at 100 to 1600 R. Significant reductions in reduced glutathione and ATP (at 200 R), glutathione-reductase (800 R) and ^{14}C-glycine uptake (1600 R) were noted. The interpretation of these findings is discussed. (auth)

22990 RADIATION-STERILIZED MAMMALIAN CELLS. Revesz, L. (Karolinska Inst., Stockholm). At. Energy Rev.; 9: No. 4, 843-51(Dec 1971).

Mammalian cells retain several vital functions after exposure to sterilizing doses of radiation. The article reviews briefly these functions in view of experimental evidence. Post-irradiation synthesis of cellular constituents and post-irradiation division competence are referred to in particular. Due to the prolonged retention of several of their functions and their protracted disintegration, the radiation-sterilized cells affect surrounding tissues in various, specific ways, and can exert a growth-promoting and/or a growth-inhibiting activity. A direct cell-to-cell effect and an indirect effect, operating via the host organism, are discussed as the mechanisms. The practical importance of the effect of radiation-sterilized cells in biological experiments, in radiation therapy of tumours and tissue transplantation have been considered. (auth)

22991 EFFECTS OF IONIZING RADIATION ON LYSOSOMES AND OTHER INTRACELLULAR MEMBRANES. Harris, John W. (Univ. of California, San Francisco). Advan. Biol. Med. Phys.; 13: 273-87(1970). (CONF-690841-4).

From third international biophysics congress; Cambridge, Mass. (29 Aug 1969).

A review is presented of the effects of radiation on intracellular membranes of lysosomes, mitochondria, nuclei, Golgi bodies, and other cellular organelles. A discussion is given of oxidation of membrane sulfhydryl groups and peroxidation of membrane lipids as mechanisms of radiation damage to membranes. There can be little doubt that the primary cellular lesion caused by ionizing radiation involves damage to DNA. The hypothesis that damage to intracellular permeability barriers constitutes a very early and pre-eminent lesion is no longer consistent with the experimental facts. This is not to deny that radiation can break intracellular membranes; indeed there is reason to believe that lysosome damage may be an important factor in the interphase death suffered by resistant nonproliferating cells, such as neutrons. Isolated lysosomes are broken by radiation doses above 500 rad, but they are far more resistant in intact cells than in sucrose. Although only limited data are available, radiation probably damages lysosomes by oxidizing membrane SH groups and, at higher doses, by peroxidizing membrane lipids. Intact cells contain mechanisms for protecting intracellular membranes against both effects and this probably accounts for the radioresistance of lysosomes in situ. Most other intracellular membranes are even less radiosensitive than lysosomes. An important exception to this general statement may be the nuclear membrane or molecules located on or near it. The recent experiments of Zermeno and Cole suggest very strongly that the nuclear membrane contains or is close to the most radiosensitive volume found in mammalian cells. Since the nuclear membrane plays an essential role in the initiation of DNA synthesis and in the movement of macromolecules (e.g., messenger RNA) from the nucleus to the cytoplasm, functional lesions at this site could play a major role in radiation-induced cell death. (H.L.W.)

22992 SITES OF RADIATION INDUCED CHROMOSOME EXCHANGES. Savage, John R. K. (Medical Research Council, Harwell, Eng.). Curr. Top. Radiat. Res.; 6: 129-94(1970).

Following a brief description of chromosome-type aberrations, the subject of sites of radioinduced exchanges is reviewed under the following topics: the site hypothesis; consequences of the site concept; chromatid exchanges; objections to the site concept; and the distortion hypothesis. (101 references) (E.R.B.)

22993 EFFECTS OF ULTRAVIOLET LIGHT ON MAMMALIAN CELLS IN CULTURE. Rauth, A. M. (Univ. of Toronto. Ontario Cancer Inst., Toronto). Curr. Top. Radiat. Res.; 6: 195-248 (1970).

An attempt was made to point out some of the technical problems in the study of uv effects on mammalian cells. The problems of accurate dosimetry are stressed since mistakes in dosimetry can make comparisons between different effects of uv light in the same laboratory or comparisons of the same effect between different laboratories meaningless. A review of the available data on the sensitivity of established lines of mammalian cells to uv light indicates that they are all similar in sensitivity when cell colony forming ability is used as a criterion. This similarity is approximately maintained when one compares different cell lines in their sensitivity to uv light at different points in the cell cycle. When the effects of uv light are measured at the level of colony forming ability, cell progression, or chromosome damage, one major fact emerges. Cells in the early part of the DNA synthetic phase appear to be most sensitive for all cell lines tested. That damage to DNA plays a central role in the effects of uv on these cells is supported by the fact that substitution of 5-bromodeoxyuracil for thymine in DNA increases the cell's sensitivity to uv as measured by both colony forming ability and chromosome damage assays. In addition, the relative efficiency of various wavelengths of uv in inactivating cells indicates that a chromophore similar in absorption to DNA must be involved. Because of recent advances in the understanding of bacterial systems capable of repairing DNA, a number of attempts were made to detect the presence of such systems in mammalian cells. By far the greatest effort has centered on whether an excision–repair–replication system is present in mammalian cells or not. After a consideration of the available data the conclusion is reached that the excision–repair–replication model based on results in bacterial cells is not entirely consistent with the mammalian cell results. An alternative model is suggested in which cells tolerate a certain amount of damage without repairing it. The amount of damage that can be tolerated may be a function of normal metabolic processes such as DNA synthesis. An effort was made to keep both the cellular and molecular data in perspective at all times since any interpretation of the biological effects of uv light on mammalian cells must be consistent with data collected at both these levels. (132 references) (auth)

22994 NONINFECTIOUS AKR MOUSE EMBRYO CELL LINES IN WHICH EACH CELL HAS THE CAPACITY TO BE ACTIVATED TO PRODUCE INFECTIOUS MURINE LEUKEMIA VIRUS. Rowe, Wallace P.; Hartley, Janet W.; Lander, Marilyn R.; Pugh, Wendell E.; Teich, Natalie (National Institutes of Health, Bethesda, Md.). Virology; 46: No. 3, 866-76(Dec 1971).

When cells of AKR mouse embryos were grown in tissue culture, only one cell in 250,000 to one in 12,000,000 produced murine leukemia virus within the first few days in culture. By 2.5 weeks in culture, 12–100 times this many cells had spontaneously begun to produce virus. By planting cultures with small numbers of AKR embryo cells, it was possible to obtain two cell lines which contained no detectable virus-producing cells for more than 60 serial transfers, despite exhaustive tests for virus and virus products. However, these lines and all 10 clonally derived sublines have the capacity to produce virus, either spontaneously or after certain experimental manipulations, including x-ray or ultraviolet irradiation, and transformation by SV40 virus. Activation of virus appears to be a very low-frequency event. These findings indicate that the majority, and probably all, of the cells in the AKR cell lines carry the full viral genome in an unexpressed form, and by extrapolation suggest that this is true of all AKR cells. (auth)

22995 PERSISTENCE OF IMMUNOGENIC FUNCTION BY ANTIGEN-EXPOSED, X-IRRADIATED PERITONEAL EXUDATE CELLS. Mohagheghpour, Nahid; Draper, Laurence R. (Univ. of Kansas, Lawrence). Radiat. Res.; 49: No. 1, 170-5(Jan 1972).

Rabbit peritoneal exudate cells (PEC) were exposed in vitro to Keyhole Limpet hemocyanin (KLH) antigen before or after exposure to 550 R x-irradiation. The ability of these cells to invoke an anti-KLH immune response was then studied in normal rabbits to which these cells were transferred. Irradiation of these cells before exposure to KLH abolished their capacity to provoke a specific antibody response; but irradiation after antigen exposure did not. These results indicate that irradiation can impair the ability of PEC to bind antigen but not their ability to migrate to or complete required interactions with immunocompetent lymphoid cells in the recipient rabbit. This effect was not apparent, however, when another antigen, bovine serum albumin, was used. (auth)

22996 EFFECT OF HYPOXIA ON THE REPAIR OF SUBLETHAL RADIATION DAMAGE IN CULTURED MAMMALIAN CELLS. Hall, Eric J. (Columbia Univ., New York). Radiat. Res.; 49: No. 2, 405-15(Feb 1972).

Chinese hamster cells were synchronized with hydroxyurea and then stored at room temperature. These G_1/S cells, were uniform in sensitivity, did not progress through the cell cycle at room temperature, and their response to a single acute exposure of x-rays remained constant for at least 24 hours of room temperature storage. These cells were used to investigate the repair of sublethal damage under aerated and hypoxic conditions. Under aerated conditions a recovery factor of 3 was observed; under conditions of extreme hypoxia, defined by the presence of less than 16 parts per million of oxygen in the gas phase, repair of sublethal damage appeared to be completely inhibited. (auth)

22997 ACTION OF IONIZING RADIATION ON MITOSIS ARRESTED BY HYPOTHERMIA. Valentini, A. F.; Olivo, O. M. (Univ., Bologna). Boll. Soc. Ital. Biol. Sper.; 47: No. 11, 325-7(15 Jun 1971). (In Italian).

The process of mitosis in a pendant drop of cultured fibroblast cells may be arrested by a temperature of 20°C for 24 hours. A culture in active proliferation was subjected to doses of ionizing radiation from 500 R to 120,000 R for various time periods. The number of mitoses in the culture treated with hypothermia, successively irradiated with various doses, and fixed after one or two hr following thermostating at 37°, was not significantly different from the number observed in the experiment in which the cultures were merely irradiated. (K.S.W.)

22998 COMPARISON OF RADIUM AND ^{252}Cf USING CULTURED MAMMALIAN CELLS. A SUGGESTED EXTRAPOLATION TO RADIOTHERAPY. Hall, Eric J. (Columbia Univ., New York). Contract AT(30-1)-2740. Radiology; 102: No. 1, 173-9 (Jan 1972).

Chinese hamster cells were irradiated at various low-dose rates with radium gamma rays and with the mixed neutron and gamma emission from californium-252. Cell killing was unaffected by a dose-rate change from 1.14 to 21.4 rads/hr for californium. For radium, there was a continuous reduction in cell-killing effect as the dose rate was reduced from 52.5 to 11.7 rads/hr. It is suggested that 890 rads of californium neutrons in a time period close to seven days is equivalent to the standard treatment of 6,000 rads of radium gamma rays in seven days. (auth)

22999 RADIATION-INDUCED DNA SYNTHESIS IN NORMAL AND STIMULATED HUMAN LYMPHOCYTES. Darzynkiewicz, Z. (Boston Biomedical Research Inst.). Exp. Cell Res.; 69: No. 2, 356-60(Dec 1971).

The rate of DNA repair, as measured by "unscheduled" incorporation of ^{3}H-thymidine following ultraviolet light irradiation, increases approx. 50% during stimulation of lymphocytes by phytohemagglutinin. This increase is parallel in time with a rise in DNA polymerase activity that occurs during stimulation, but is almost two orders of magnitude lower than the increase in enzyme activity. The rate of DNA repair in granulocytes is five times lower than in unstimulated lymphocytes. The possible involvement of DNA polymerase in DNA repair replication is discussed. (auth)

23000 REPRODUCTIVE SURVIVAL OF MAMMALIAN CELLS AFTER IRRADIATION AT ULTRA-HIGH DOSE-RATES: FURTHER OBSERVATIONS AND THEIR IMPORTANCE FOR RADIOTHERAPY. Berry, R. J.; Stedeford, J. B. H. (Churchill Hospital, Oxford). Brit. J. Radiol.; 15: No. 531, 171-7(Mar 1972).

Conflicting data from earlier experiments suggested that under certain conditions, survival curves for the reproductive capacity of mammalian cells irradiated at ultrahigh dose-rates (ns-to-μs pulses) with x rays or high-energy electrons exhibited an inflected "hockey-stick" shape. Other workers failed to observe such "hockey-stick" survival curves when using apparently similar radiation conditions. Using a 400 keV electron beam with a pulse duration of about 3 ns, dense monolayers of HeLa cells were irradiated attached to plastic Petri dishes, or dense monolayers of P.388 murine ascites leukemia cells were irradiated suspended on membrane filters. The cells were either aerobic, hypoxic, or in a 0.35% oxygen/nitrogen atmosphere at the time of irradiation. Survival of HeLa cells was assessed by the ability to form macroscopic clones in vitro; survival of P.388 leukemia cells was assessed in vivo by tumor "takes" from serial dilutions of the tumor cells in isologous mice. Up to doses of about 1,500 rads (surviving fraction $\sim 10^{-3}$ for HeLa, $\sim 10^{-6}$ for P.388) the survival curves were uninflected, as were the curves for irradiation in nitrogen up to doses of about 3,500 rads. OER values were >2.5 for both HeLa cells and the P.388 leukemia. However, irradiation in 0.35% oxygen/nitrogen produced an inflected "hockey-stick" survival curve which, above doses of a few hundred rads, was effectively parallel to the curve for cells irradiated in nitrogen. Results are presented that indicate that "radiobiological hypoxia" can be produced in mammalian cells by irradiation with ns pulses only in cells already at a reduced level of oxygen. (auth)

23001 RBE AND OER OF π MESONS FOR DAMAGE TO CULTURED T-1 CELLS OF HUMAN KIDNEY ORIGIN. Raju, M. R. (Univ. of California, Berkeley. Univ. of Texas, Dallas); Gnanapurani, M.; Richman, C.; Martins, B. I.; Barendsen, G. W. Brit. J. Radiol.; 45: No. 531, 178-81(Mar 1972).

Cultured cells of human kidney origin (T-1 cells) were used to measure the oxygen-enhancement ratio of π^- mesons at the peak of the depth-dose distribution and the biological effectiveness of π^- mesons was compared with that of ^{60}Co γ rays. The OER appeared to be dose dependent, and had values of 1.9 and 1.5 at survival levels of 50 and 10% respectively. The relative biological effectiveness of π^- mesons was found to be between 2.2 and 2.4 for oxygenated cells. The OER of ^{60}Co γ rays (240 R/hr) was 2.6 and 2.3 measured at 50 and 10% survival, respectively. Similar measurements with Chang liver cells yielded identical values for the OER of π^- mesons. (auth)

23002 REPAIR REPLICATION IN MAMMALIAN CELLS AFTER X-IRRADIATION. Painter, R. B.; Young, B. R. (Univ. of California, San Francisco). Mutat. Res.; 14: No. 2, 225-35 (Feb 1972).

The qualitative and quantitative characteristics of repair replication after x irradiation are similar in Chinese hamster B14FAF cells, mouse P388F cells, and human (diploid) WI-38 cells. Calculations of the amount of DNA damage per cell and number of bases inserted per damaged site indicate that degradation at each damaged site does not exceed three bases; this small amount of base insertion cannot be detected in the presence of the nonconservative synthesis occurring in controls until the damage to DNA is extensive—more than that caused by 1000 rad. Similar calculations using the data of Ayad and Fox on P388F cells indicate that the extensive synthesis reported by these workers is not restricted to damaged sites in DNA and therefore must not be related to repair. (auth)

23003 DISSOCIATION OF HISTONE AND DNA SYNTHESIS IN X-IRRADIATED HeLa CELLS. Bases, R.; Mendez, Frances (Albert Einstein Coll. of Medicine, New York). Exp. Cell Res.; 69: No. 2, 289-94(Dec 1971).

Although histone synthesis and DNA synthesis are normally very well coordinated in HeLa cells, their histone synthesis proved relatively resistant to inhibition by ionizing radiation. During the first 24 h after 1000 R the rate of cellular DNA synthesis progressively fell to small fractions of control values while histone synthesis continued with much less relative reduction. Acrylamide gel electropherograms of the acid soluble nuclear histones synthesized by irradiated HeLa cells were qualitatively normal. (auth)

23004 IRREVERSIBLE LOSS OF NEGATIVE SURFACE CHARGE AND LOSS OF COLONY-FORMING ABILITY IN BURKITT LYMPHOMA CELLS AFTER X IRRADIATION. Sato, C.; Kojima, K. (Aichi Cancer Center Research Inst., Nagoya, Japan). Exp. Cell Res.; 69: No. 2, 435-9(Dec 1971).

The electrokinetic behavior of Burkitt lymphoma P 3H-R1 cells was studied following x-irradiation. The surface charge of irradiated cells decreased progressively with time after x-ray treatment, as compared with a mean mobility value (-0.677 ± 0.045 μsec^{-1} V^{-1} cm) of non-irradiated cells. The frequency distribution of cells treated with 3000 R 4 h previously showed quite a different peak of lower mobility than that of non-irradiated cells with the boundary of -0.550 μsec^{-1} V^{-1} cm. Percentages of cells which showed the higher mobility than the boundary value 4 h after irradiation with 30, 50, 65, 100, 200 or 3000 R were in accord with the percentage of cells which showed colony-forming ability in soft agar, respectively. Following cell proliferation the population of electrokinetically intact cells increased with time after irradiation; these values also coincided with the population of colony-forming cells. Thus, the present results indicate that there is a close relation between loss of negative surface charge and loss of colony forming ability in irradiated cells, suggesting that loss of colony forming ability of the cells may be determined as early as 4 h after irradiation. (auth)

23005 SENSITIVITY TO RADIATION AND INSENSITIVITY TO VINBLASTINE OF THE INDUCER FUNCTION OF THYMUS-DERIVED CELLS. Itao, Takaaki; Cudkowicz, Gustavo (State Univ. of New York, Buffalo). Cell. Immunol.; 2: No. 6, 595-6 (Dec 1971).

Thymic antigen-reactive cells stimulated by sheep erythrocytes generate specific inducer cells facilitating differentiation and maturation of marrow precursors into immunocytes (direct and indirect plaque-forming cells). This function is abolished by in vitro exposure of inducer cells to 1000 rads of gamma rays, but not by their in vivo exposure to the drug vinblastine which is cytocidal for cells entering mitosis. Thus, the cooperative function of inducer cells in anti-sheep immune responses is radiosensitive even when the cells are not dividing. Other helper functions of thymus-derived cells are radioresistant, e.g., the function of carrier-specific cells and of cells reconstituting spleens of thymectomized mice. Differences in radiosensitivity of helper functions suggest that more than one cell type and/or mechanism may be utilized for triggering marrow-derived precursors of immunocytes. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 22945, 22951, 22980, 22985, and 23053.

23006 (CONF-711041–(Absts.)) 3rd AINSE RADIATION BIOLOGY CONFERENCE 1971, 25th AND 26th OCTOBER 1971 AT LUCAS HEIGHTS. Abstracts of Papers. (Australian Inst. of Nuclear Science and Engineering, Lucas Heights). 25p.

Abstracts of 25 papers are presented. Topics dealt with include radiation effects on bacterial spores; uv effects on DNA, skin and plasmalemma; induced mutation and cytogenetics; population kinetics; radiopharmaceuticals, radioecology and Drosophila genetics; and radiation effects in bacterial genetics. (Australia)

23007 (KURRI-TR-84, pp 7-13) DIVERSITY AND UNIVERSALITY OF RECOVERY FROM RADIATION INJURIES. RECOVERY OF BACTERIOPHAGE FROM DISORDER INDUCED BY ULTRAVIOLET RADIATION. Takebe, Hiraku (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

Infectious DNA and transduction DNA of bacteriophage P22 that received uv irradiation were not recovered in Hcr^- strain. But a mutant (42-2) was discovered in the Hcr^- strain that could not recover infectious DNA but could recover transduction DNA. This fact suggested that there were at least two steps during the early period of recovery of the host cells and that between the two steps such condition as to promote rearrangement of the host DNA and transduction DNA took place. Thus, recovery was promoted in a condition that homologous DNA was rearranged while the other DNA received uv irradiation, but lysogenization that was thought to be rearrangement of phage-infected DNA and the host DNA was not promoted by uv. This was found out by the fact that the effect of the host lethality of lysogenic phage and the non-lysogenic mutant, infectious DNA that received uv irradiation, appeared without promoting lysogenization. Thus, recovery from disorder by uv in DNA that phage transmitted showed diversity according to the origin of DNA and the way of detection. But it could be explained universally by repair of host cells as a mechanism. (Japan)

23008 (KURRI-TR-84, pp 14-20) ENZYMIC SYSTEM FOR REPARATION OF DNA DISORDER IN PHAGE AND BACTERIA. Sekiguchi, Mutsuo; Yasuda, Seiichi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

Investigations in vitro on the mechanism of the reparation of DNA that received uv irradiation using bacteria and phage were summarized. Especially regarding the breaking activity of pyrimidine dimer induced in Escherichia coli by T4 phage infection, available information at present of the mechanism of reaction and the biological role were summarized. The first step of reparation of DNA was thought to be breaks of single strand of the polynucleotide chains of DNA by the peculiar action of endonuclease. The location of these breaks was presumed to be in the 5′ side of the pyrimidine dimer, judging from the mechanism of enzymic action. As the activity of this enzyme was not induced in uv radiosensitive mutant $T4^v$, it was thought that formation of this enzyme was controlled by a gene $^{v+}$ in phage T4 and also that this enzyme acted for reparation of the disorder in vivo. The second step of reparation was thought to be dissection of the oligonucleotide-containing dimer by the action of the other enzyme. Some consideration on the mechanism was also given. (Japan)

23009 (KURRI-TR-84, pp 26-9) MODALITY OF THE PRESENCE AND REPARATION OF DNA. Tanooka, Hiroshi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

The differences in the radiosensitivity of the intracellular DNA according to the modality of the presence of DNA in the cells were demonstrated by transforming the shape and quality of the DNA in spores of Bacillus subtilis, the extent of severance of the single strand, and formation of photoproducts. Repair of these injuries is observed at the time of germination of the spore, but the process of repair is all specific to the spore and is different from the repair mechanism of other nutrient cells. It seems to be due to the qualitative specificity of the injury itself. (Japan)

23010 (KURRI-TR-84, pp 30-5) SPECIFICITIES OF THE STRAINS LACKING THE REPAIR DNA SYNTHESIS OF ESCHERICHIA COLI. Kato, Takeshi (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

Mutants were isolated that were thought to have a deficiency in the repair DNA synthesis among the radiosensitive strains of E. coli. It was found that the mutable gene controlling the radiosensitivity of these res strains controls the polymerase activity of DNA also. It is highly possible that polymerase is involved in the repair of injured DNA. The present report deals chiefly with the analysis of res strains by the genetic approach from which it was concluded that the function of the res gene was involved in the repair DNA synthesis in the process of excision repair. This conclusion should wait for biochemical proof. The interesting evidence observed in the res strains in view of the repair mechanism of radiation injuries, which is the aim of the present study group, is that strains lacking repair show high sensitivity to x rays also. The details of the repair of x-ray injury have not been fully elucidated yet, but when our hypothesis, i.e., "res strains lack repair synthesis which is performed by the DNA synthesizing enzyme", is considered in relation to radiosensitivity, it is highly probable that in repair of x-ray injury also, the repair synthesis by DNA polymerase is involved. Through the study of res strains one can consider the function of repair synthesis not only as the role of repair of radiation injury but also as a part of the function that the organism acquired for maintenance of the stability of genetic transmission. The study of the biological radiation effects is aimed at the problem associated with the essentials of life and its importance is recognized. (Japan)

23011 (KURRI-TR-84, pp 72-7) RELATIONSHIP BETWEEN FORMING MECHANISM OF MUTATION AND DNA REPAIR. BIOLOGICAL MEANING OF ERROR AND REPAIR OF DNA. Kondo, Sohei (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

An organism has various mechanisms for recovery from damage caused by radiation injuries. Repair mechanisms of damage of DNA caused by irradiation have been best studied. What will be the biological meaning of repair of DNA? An assumption is presented here that in spite of the fact that the function of an organism, being under control of physical laws, is destined to vanish with the increase of entropy, in other words, the increase of DNA errors, it barely survives by having correcting mechanisms for errors inside of it, and the proof is that one of these correcting functions suggests the DNA repairing. Mutants of Res^- (impossible to repair or synthesis) or Rec^- (impossible to rearrange) strains of E. coli that lack DNA repair are easily killed by x ray, their natural death rates are high, and their spontaneous mutation rates are higher (Res^-) or lower (Rec^-) compared to the normal strain. Since mutation reflects DNA errors, Res^- strain is probably a strain that lacks repair mechanisms for natural DNA errors. DNA damage due to x rays is one of the best simulations of natural DNA error. (Japan)

23012 (STI/PUB-287) RADIATION AND RADIOISOTOPES FOR INDUSTRIAL MICROORGANISMS. Proceedings Series. Proceedings of a Symposium Held in Vienna, 29 March–1 April 1971. (International Atomic Energy Agency, Vienna (Austria)). Aug 1971. 347p. (In several languages). (CONF-710341). IAEA $9.00.

Separate abstracts were prepared for twelve papers presented at the conference. An additional nineteen papers were presented on various aspects of industrial microbiology. (H.L.W.)

For abstracts of individual papers see: 22770, 22981, 23018–23024, and 23043–23045.

23013 (TID-25895) EFFECTS OF ERGOSTEROL, PALMITIC ACID, AND RELATED SIMPLE LIPIDS ON THE RECOVERY OF CANDIDA ALBICANS FROM ULTRAVIOLET RADIATION. Sarachek, A.; Higgins, N. P. (Wichita State Univ., Kans.). [1971]. Contract AT(11-1)-1772. 33p. Dep. NTIS.

Wild type cells were grown on peptone-yeast extract enriched agar media and filter-sterilized lipid solutions were added to media for studies on comparison of various lipids for radiobiological effects. Compounds tested included simple saturated fatty acids from two through 20 carbons in length, mono-, di-, and trienoic analogues of stearic acid, and cholesterol, ergosterol, and the sterol precursor, squalene. It was found that the long chain saturated fatty acids, squalene, and the sterols were most active in promoting survival following uv irradiation. The effect was observed only for cells not budding at the time of irradiation. Lipids had no effect on uv mutagenesis. A survey of a number of yeasts indicated that the capacity for lipid-induced recovery from uv was

a species specific characteristic of yeasts. The behavior of cells damaged by uv and by amphotericin B, a membrane specific fungicidal antibiotic, suggested that lipids remediate a uv-induced derangement of the structure of the cell membrane critical for the initiation of cell division. (H.L.W.)

23014 (TID-25915) STUDIES ON THE SUBSTRATE SPECIFICITY OF THE T4 EXCISION REPAIR ENDONUCLEASE. Friedberg, Errol C. (Stanford Univ., Calif. Dept. of Pathology). [1971]. Contract AT(04-3)-326. 21p. Dep. NTIS.

Previous studies have shown that the V gene of bacteriophage T4 codes for an endonuclease that specifically attacks pyrimidine dimer sites in uv-irradiated DNA. The present studies have examined the role of this endonuclease in the repair of DNA damaged by nitrogen mustard, N-methyl-N′-nitro-N-nitrosoguanidine, mitomycin C and 4-nitroquinoline-N-oxide. It was shown that infection of uv-irradiated E. coli B_{s-1} with uv-inactivated phage T4 or $T4V_1$ resulted in rescue of a certain fraction of the host cells by phage T4 (V-gene reactivation). However no V-gene reactivation of E. coli B_{s-1} was observed following treatment with the chemical agents mentioned. Furthermore, though phage $T4V_1$ is more sensitive to uv-irradiation than phage T4, there was no observed difference in the sensitivity of these phages to nitrogen mustard or NTG. On the basis of these observations it was concluded that the V-gene coded endonuclease of T4 is specific for the excision repair of pyrimidine dimers and does not participate in the repair of chemically-damaged DNA. In vitro enzymatic degradation of DNA alkylated with nitrogen-mustard was observed, but it is probable that this degradation is not part of a repair reaction in vivo. (auth)

23015 (TID-25950) PLANETARY QUARANTINE PROGRAM. Twenty-Third Quarterly Report of Progress for Period Ending December 31, 1971. (Sandia Labs., Albuquerque, N. Mex.). Dec 1971. Contract W-12,853. 62p. Dep. NTIS.

Progress is reported on studies related to the sterilization of microorganisms on the surface of spacecraft. Data are included from a study on the effects of uv radiation on the survival of spores of Bacillus subtilis. (C.H.)

23016 HYGIENIC STUDIES ON LAVER OF KOREA. II. THE EFFECTS OF ^{60}Co-RAY IRRADIATION ON THE DEFORMATION OF VITAMIN C, ITS BACTERICIDAL ACTIVITY IN PURPLE LAVER. Park, Dae Sung; Cho, Hyun Young; Kim, Kwang Ho. Korean J. Microbiol.; 4: No. 2, 65-8(1970).

In continuation of the previous work (The New Medical Journal, Vol. 12 No. 3, 111, 1969), the effects on the bactericidal activity against coliform bacteria, on vitamin C content, and ascorbate oxidase activity of the purple laver due to ^{60}Co gamma-irradiation were studied. After the 0.1 mrad/hr doses of gamma irradiation for 1 h to the laver, the coliform bacteria were remarkably destroyed and after application for 10 h the coliform bacteria were completely destroyed. Vitamin C content gradually decreased during gamma irradiation of the laver. According to the sensory test, no changes in color were indicated for 9 to 10 h treatment. But the loss of ascorbic acid was much more than that of dehydroascorbic acid after 10-h treatment. The ascorbate oxidase activity due to the irradiation was conspicuously decreased. (Korean Sci. Abstr.)

23017 RADIATION-INDUCED RECOMBINATION IN SACCHAROMYCES: ISOLATION AND GENETIC STUDY OF RECOMBINATION-DEFICIENT MUTANTS. Rodarte-Ramon, Ubaldo S.; Mortimer, R. Robert K. (Univ. of California, Berkeley). Radiat. Res.; 49: No. 1, 133-47(Jan 1972).

Yeast mutants, deficient in x-ray- and ultraviolet light (uv)-induced mitotic heteroallelic reversion, were isolated from disomic cells. Of ten identified mutants, seven were studied in detail. The mutants exhibited depressed frequencies of x-ray- and/or uv-induced reversion in the heteroallelic region arg4-2 +/+ arg4-17 on disomic chromosome VIII. Two of the mutants are x-ray sensitive and one is both x-ray and uv sensitive. The remaining four strains exhibited wild-type response to both radiations. Six of the mutations segregated as one recessive gene. Complementation and allelism tests were performed and a minimum of four genes, denoted rec1, rec2, rec3, and rec4 were identified among these six mutations. It is suggested, by analogy with results obtained in E. coli, that induced lesions in DNA serve as substrate for recombination, while rec mutants are unable to complete the steps required for exchange. Wild-type sensitivity to radiation-induced damage in four mutants suggests that recombination in yeast may also proceed in pathways not involving repair of radiation damage. (auth)

23018 MICROBIOLOGICAL GENETICS AS A THEORETICAL BASIS FOR THE SELECTION OF INDUSTRIAL MICROORGANISMS. Alikhanyan, S. I. (Inst. of Genetics of Industrial Microorganisms, Moscow). pp 3-9 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

On the basis of concrete examples taken from the history of the development of the microbiological industry in the Soviet Union and the rest of the world, the theme is developed that the decisive factor in the rapid progress of microbiological synthesis on an industrial scale is the improvement of genetic methods for work with mircoorganisms. It is shown that by applying methods developed along traditional lines, in particular methods of producing mutagenesis by means of x-rays, ultraviolet rays or fast neutrons, a striking success has been achieved in the selection of strains producing antibiotics. Side by side with these methods an important role has been played by biochemical mutations, particularly in the breeding of strains producing amino acids. A summary is given of the results of the initial work on increasing the yields of microorganisms, a characteristic being its empiricism. At the present time, characterized by the rapid development of activities in the field of molecular genetics and also by advances in the microbiological industry, progress is being made towards gearing theoretical research to the practical needs of the microbiological industry. In conclusion, a review is presented of the latest achievements and ideas in molecular genetics that are likely to be of use in the task of selection in the future. (auth)

23019 MOLECULAR MECHANISMS OF MUTATION. Heslot, H. (Institut National Agronomique, Paris). pp 13-42 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

A review is presented of the principal categories of mutagenic agents: analogues, hydroxylamines, nitrous acid, alkylating agents, acridines, ultraviolet rays, and ionizing radiations. Their mode of action and mutagenic activities are discussed. The different kinds of repair mechanisms are reviewed and their importance is stressed. A few recommendations are given for the proper choice of mutagenic agent. (auth)

23020 BASIS FOR RADIOSENSITIVITY OF SOME MUTANTS OF HEMOPHILUS INFLUENZAE. Notani, N. K.; Joshi, V. R.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Trombay, India). pp 43-51 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

Four uv-sensitive mutants, including one that was also sensitive to gamma radiation, of Hemophilus influenzae were isolated and characterized in regard to their ability to form colonies after uv- and gamma-irradiation, to produce transformants from uptake of genetically marked, irradiated DNA, and to yield phage progeny when infected with phage HP_1c_1. Mutants N12, N17, N19 and N21 showed, respectively, a 20, 18, 2 and 20-fold greater sensitivity than the wild type. Mutants N12 and N21 are also defective in the repair of extra-cellularly irradiated transforming DNA. Mutants N17 and N21 have a lower capacity than the wild type to do the host-cell reactivation of irradiated phage. Measurement of thymine dimers in cellular DNA following uv-irradiation showed that mutants N12 and N21 are defective in the repair mechanism of excising thymine dimers. Mutant N17, although normal in regard to thymine-dimer excision, was found to be slow in rejoining of the DNA breaks. Coincidentally, mutant N17 is also somewhat sensitive to gamma radiation. The basis for the sensitivity of mutant N19 is not understood at present, but it is observed to have a most unusual property of giving differential transformations for two-linked markers Sr (resistance to streptomycin) and Cr (resistance to cathomycin) following uptake of unirradiated DNA; the transformation for Cr is about $^{1}/_{100}$th that of Sr. The uptake of gamma-irradiated DNA (in buffer) by competent cells is near-normal but the integration of input DNA into the resident DNA is reduced. Furthermore, the reisolated, unintegrated irradiated input DNA is observed to have lower average molecular weight than unirradiated input DNA. The inactivation of biological activity of transforming DNA, after gamma irradiation, is thus correlated with strand breakage. (auth)

23021 PHYSIOLOGICAL AND GENETICAL STUDIES ON YEASTS OF THE GENUS CANDIDA. Gaillardin, V.; Heslot, H. (Institut National Agronomique, Paris). pp 93-111 of Radiation

and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

The degree of ploidy has been studied in Candida tropicalis and Endomycopsis lipolytica by determining the DNA content, the shape of the survival curve after x-irradiation and the response to mutagenic agents. Sexual behavior has also been investigated. A number of auxotrophic mutants were induced. (auth)

23022 MUTATION STUDIES IN STREPTOMYCES AUREOFACIENS. Blumauerova, M.; Ismail, A. A.; Hostalek, Z.; Vanek, Z. (Inst. of Microbiology, Prague). pp 157-66 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

Biochemical mutants of Streptomyces aureofaciens, which were blocked in the biosynthesis of tetracycline antibiotics and marked by additional blocks in the primary metabolism, were induced by physical and chemical mutagens. Ultraviolet light and N-methyl-N'-nitro-N-nitrosoguanidine were the most efficient mutagens in both mutation steps. The mutagen and strain specificity, some correlations between the biosynthetic activity and other mutant characteristics as well as the convenience of the methods used are discussed. (auth)

23023 SELECTION OF MUTANTS NOT ACCUMULATING STORAGE MATERIALS. Schlegel, H. G.; Oeding, V. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). pp 223-31 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

The production of single-cell protein has been recommended in order to increase the protein resources for animal and human nutrition. Microorganisms generally accumulate reserve materials (triglycerides, poly-β-hydroxybutyrate or glycogen) when growing under conditions of optimal biosynthetic efficiency for biomass production. These reserve materials are non-proteinaceous; their production should therefore be avoided. One way to suppress the production of non-proteinaceous matter is the utilization of mutants which are blocked in the synthesis and accumulation of reserve materials. Methods to select for and isolate such mutants have been developed using the hydrogen oxidizing bacterium, Hydrogenomonas eutropha strain H16. This bacterium is very well suited for the production of single-cell protein on the basis of molecular hydrogen, oxygen and carbon dioxide, and is seriously considered for application in bioregenerative systems (space trips) and for food production from electricity via water electrolysis. The methods for the isolation of lipid-free mutants involve the use of ultra-violet light as the mutagen and ^{32}P-phosphate as a selective agent. By applying the ^{32}P-suicide method it is possible to selectively kill the wild-type cells and leave those mutants unimpaired which do not accumulate the lipid poly-β-hydroxybutyrate. Another selective method, which has been developed recently, is based on sucrose density centrifugation. Details of these methods and the physiological properties of the mutants isolated so far are discussed. (auth)

23024 RADIATION IMPROVEMENT OF CANDIDA NO. 25 FOR PETROPROTEIN FERMENTATION. Ting, Shu-hsun; Li, Chaun-hsian; Lee, Ching-song (Chinese Petroleum Corp., Taiwan). pp 259-65 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

For the purpose of studying the production of petroprotein by fermentation with petroleum as the sole carbon source, Candida No. 25 was isolated in July 1964 from the soil around the diesel-oil storage tank in the Kaoshiung Refinery. To improve the fermentation efficiency of the strain it was first exposed to uv-irradiation. After the radiation was performed several times, the results showed that the new isolated mutant grew rapidly in the high concentration of hydrocarbon. Not only was there an increase in cell concentration in the broth from 8 to 35 g/l, but there was also a shortening in the necessary fermentation period from 72 to 36 hours. The improved strain showed great stability after being transferred from a 5-litre fermentor in the laboratory to a 5000-litre fermentor and even to a 150,000-litre fermentor in which more than ten running tests were made. Now, further experiments are under way with x-rays and gamma rays to achieve improved strains of microorganisms that would be suitable for petroprotein fermentation on a commercial scale. (auth)

23025 EFFECT OF IONIZING RADIATION ON THE MOLECULAR BIOLOGY OF ESCHERICHIA COLI. Pollard, Ernest C. (Pennsylvania State Univ., University Park). Curr. Top. Radiat. Res.; 6: 51-127(1970).

An extensive review of the subject is presented under the following topics: ionizing radiation and living cells; physical action of ionizing radiation; critical target concept; molecular biology of bacteria; comparison with mammalian cells; colony-forming ability; observation of single cells after radiation; peroxides and effects of irradiated medium; ionizing radiation and DNA degradation; ionizing radiation and DNA synthesis; ionizing radiation and respiration; ionizing radiation and transcription and translation; effects of the decay of incorporated radioactivity; and mutations. An annotated list of 9 review articles is presented in addition to 91 references. (E.R.B.)

23026 ISOLATION AND SOME RADIOBIOLOGICAL PROPERTIES OF MUTANTS OF MICROCOCCUS RADIODURANS SENSITIVE TO IONIZING RADIATIONS. Suhadi, F.; Kitayama, S.; Okazawa, Y.; Matsuyama, A. (Inst. of Physical and Chemical Research, Saitama, Japan). Radiat. Res.; 49: No. 1, 197-212 (Jan 1972).

Five partially temperature-sensitive mutants were isolated from wild-type Micrococcus radiodurans. Radiosensitivity of the mutants has been determined. The restitution process in the mutants was relatively sensitive to radiation. The delayed DNA repair in the mutants was due to an alteration of the restitution process, but not to change in degradation system. The enhanced cell death in the mutant cells is closely associated with delayed DNA repair. (auth)

23027 RADIATION-INDUCED RECOMBINATION IN SACCHAROMYCES: THE GENETIC CONTROL OF RECOMBINATION IN MITOSIS AND MEIOSIS. Rodarte-Ramon, Ubaldo S. (Univ. of California, Berkeley). Radiat. Res.; 49: No. 1, 148-54(Jan 1972).

Four rec genes, responsible for a deficient mitotic conversion in yeast, have been studied for their effects on mitotic crossing over and in meiotic intragenic and intergenic exchanges. Mutations in rec1 do not affect either mitotic segregation of ade2 or meiotic intragenic or intergenic recombination. Homozygous rec2/rec2 diploids yield 1 to 2% sporulation and 10% spore viability. They also exhibit normal frequencies of x-ray induced mitotic crossing over of ade2. Mutations in rec3 suppress sporulation, but do not affect mitotic segregation of cyh2. Diploids homozygous for rec4 show normal frequencies for x-ray induced mitotic crossing over in ade8. Such diploids exhibit 60% sporulation and 90% spore viability. Intragenic meiotic recombination between alleles 2 and 17 in arg4 is reduced about 500 times. Meiotic crossing over appears normal for the region between mating type and ade8 and their respective centromers and also in the intervals between thr1 and CUP1 and the centromere of chromosome VIII. Common processes for mitosis and meiosis are suggested by the existence of mutants in rec2, rec3, and rec4. Mutations in rec4 suggest common steps for single site conversions in mitosis and meiosis. (auth)

23028 NEGATIVE INTERFERENCE IN ESCHERICHIA COLI K12 AND ITS BEARING ON THE MECHANISM OF GENETIC RECOMBINATION. Mahajan, Suresh Kumar. Philadelphia; Univ. of Pennsylvania (1971). 203p. University Microfilms Order No. 71-26,058.

Thesis.

The phenomenon of negative interference was studied in intercisteronic crosses of the E. coli K12 conjugation system. The first step in this process was the preparation of E. coli K12 strains carrying different combinations of one or more of the same eight easily scorable markers (dra, ser B, trp R, thr, pyr A, ara, leu, and nadC) located in different genes in a small (1.6 min long) chromosomal region around the thr locus. All the males used were derivatives of Hfr H and were prototrophic for all markers outside the above group. The females generally also carried some outside markers. Chromosomal distances between different pairs of markers were measured using the techniques of interrupted mating and x-ray induced recombination. Two-factor crosses were performed to measure the pairwise recombinational frequencies. Negative interference effects were studied in three-, four- and five-factor crosses. A new improved measure of interference, the coefficient of coincident recombination c, was defined and measured in all the above crosses along with the classical interference index i. The results showed the presence of a pronounced localized negative interference in E. coli K12, some of the above intercistronic crosses yielding values of i greater than 30. This inter-

ference was strongest when the distances involved were small (≤0.5 min), fell off steadily with increasing distance and disappeared almost completely for distances longer than two minutes. Qualitatively, the data were consistent with the cluster-hypothesis of recombination according to which all genetic exchanges are confined to small recombination-regions which are distributed discontinuously along the length of the genome with long intervening regions of no-recombination. A detailed mathematical formulation of the above hypothesis was developed assuming (i) a random distribution of the recombination-regions on the chromosome, (ii) a random distribution of genetic exchanges inside the recombination-regions and (iii) a random dimorphic distribution for the beginnings and ends of the recombination regions. All these assumptions were empirically supported by the experimental data. For two well-separated markers in symmetric matings, the theory gave a mapping function which had a form similar to that of Haldane's classical mapping-function but which exhibited a more detailed dependence of the recombinational frequency on the three parameters (n_r, the mean density of recombination-regions on the chromosome; n_e, the mean density of genetic exchanges inside the recombination-regions; and l, the mean length of the recombination-regions) of the cluster-hypothesis. The expression for the frequency of coincident-recombinations $R_2(1)$ in 3-factor crosses, gave correct expected behavior in the limiting regions. The values of $R_2(1)$ calculated from this expression showed a very good agreement with the experimental values thus providing strong support for the cluster hypothesis and the postulates stated above. Values of the parameters n_r, n_e and l as estimated from the data of 3- and 4-factor crosses were $n_e \simeq 2.2 \pm 0.4$ exchanges per min; $l = 0.48 \pm .11$ min per recombination-region; and $n_r = 0.14$ recombination-regions per min of the chromosome. Further support for the cluster-hypothesis was obtained from an experimental study of the effect of zygotic x irradiation on the recombination frequencies in two-, three-, and four-factor crosses. X-ray doses up to 30 krads had little effect on the frequencies of coincident recombination in adjacent regions among recombinants selected for recombination in a given small interval. The same doses increased the two-factor frequencies to several-fold. This was as predicted by the "cluster-hypothesis." Significance of the above results with respect to the mechanism of genetic recombination in the E. coli system are discussed. The data would be consistent with a dual mechanism of recombination involving classical crossing-over type of events resulting from a double-strand breakage and reunion of the parental DNA's, and gene conversion type of events resulting from excision of single strand segments of the DNA of one parent followed by their replacement with the corresponding single strand sections from the other parent. (Diss. Abstr. Int., B)

23029 INFLUENCE OF GAMMA-IRRADIATION ON THE GLUCOSE-6-PHOSPHATE-DEHYDROGENASE ISOZYMES OF SYNCHRONOUS CHLORELLA CELLS. Cabela, E.; Altmann, H. (Inst. of Biology, Seibersdorf, Austria). Kerntechnik; 13: No. 12, 556-7(Dec 1971).

The distribution of G6PD-isozymes in Chlorella cells during a mitotic cycle is dependent upon the cell stage. Disc electrophoretic separations of G6PD of autospores and of cells in the late dark period showed up to five isozyme patterns, whereas in cells at the maximum photosynthesis and at the beginning of the dark period the enzyme activity is localized in one band only. After irradiation of the cells with 20 krad, no change in the G6PD-isozyme distribution was observed, but a stimulating effect especially in cells investigated during photosynthesis occurred. (auth)

23030 POSTRADIATSIONNAYA REPARATSIYA. (Postradiation Reparation). Paribok, V. P. (ed.). Sovremennye Problemy Radiobiologii. Tom I. (Contemporary Problems of Radiobiology. Volume I). Moscow; Atomizdat (1970). 336p.

This book represents a collection of nine papers by various authors on the subject of restoration of chromosomes following uv radiation injury, mutagenic damage, and the degradation of DNA in uv-irradiated bacteria. Post-radiation repair of a number of species of bacteria, radioresistance, ultra-sensitive mutants, sublethal and lethal doses of uv radiation, and survival of bacteria under various environmental conditions are considered in detail. (K.S.W.)

23031 MUTATION FREQUENCY DECLINE FOR STREPTOMYCIN-RESISTANT MUTATIONS INDUCED BY ULTRAVIOLET LIGHT IN ESCHERICHIA COLI B/r. Clarke, Colin H.; Hill, Ruth F. (York Univ., Toronto). Mutat. Res.; 14: No. 2, 247-9 (Feb 1972).

Mutation frequency decline (MFD), the irreversible reduction in yield of some classes of uv-radioinduced mutations upon temporary post-irradiation inhibition of protein synthesis, was demonstrated for streptomycin-resistant mutations induced by uv irradiation in Escherichia coli B/r. Under post-irradiation conditions promoting MFD, a five-fold decline in uv-radioinduced streptomycin-resistant mutations was observed. Although less than the 12.4-fold decline in Trp+ mutations previously reported, the present results fit well with the concept that MFD is actually a reflection of generalized excision repair going on throughout the genome, rather than uniquely restricted to a small proportion of those lesions induced by uv irradiation in only a few nonsense suppressor loci within the total genome. (E.R.B.)

23032 SYNERGISTIC EFFECT BETWEEN RADIATION AND HEAT ON MOLDS. Okazawa, Yoshishige (Inst. of Physical and Chemical Research, Saitama, Japan). Rikagaku Kenkyusho Hokoku; 47: No. 5, 211-16(Sep 1971). (In Japanese).

In regard to radiopasteurization of fruit juice, increase of radiation lethal effect on fungal conidia by a treatment combined with heating was studied. The results obtained with conidia of Penicillium terrestre showed the same extent of enhanced lethality when the heat treatment was performed before or after irradiation, while simultaneous heating during irradiation seemed most effective. The dose multiplying factors calculated from dose-survival curves indicated that they increased linearly with rise of temperature when treated before or after irradiation, being nearly 1 with the treatment for 10 min at 45°C, increasing to 2 at 50°C and reaching 3 at 55°C. The 10% survival doses of blastospores and clamydospores of Pullularia pullulans, which were higher than 500 krad with unheated spores, reduced to 300 krad and 60 krad by the preceding heat treatments of 10 min at 50°C and 55°C, respectively. (auth)

23033 ISOLATION OF MOLDS FROM AUSTRIAN APPLE JUICE AND THEIR RADIOSENSITIVITY. Okazawa, Yoshishige (Inst. of Physical and Chemical Research, Saitama, Japan). Rikagaku Kenkyusho Hokoku; 47: No. 5, 205-10(Sep 1971). (In Japanese).

For the purpose of establishing basal conditions for radiopasteurization of Austrian apple juice, contaminative molds were isolated from an apple juice and the sensitivity to gamma radiation was determined with their conidia. It was found that eight cultures so far identified, i.e. Mucor fragilis, Penicillium frequentans, P. roqueforti, P. regulosum, P. terrestre, Cladosporium spherospermum, Epicoccum nigrum, and one Rhinocladiella species, were the genus or species that had never been isolated from apple juice. All of the dose-survival curves obtained with conidia of five strains showed the sigmoidal type having the D_{10} values between 24 and 42 krad. The inactivation factors were calculated as 6.6 to 12.1 at a dose of 300 krad that was recommended for the irradiation treatment of fruit juice. Remarkable decrease in radiosensitivity was noted when the conidia were irradiated in atmospheric nitrogen instead of oxygen or air. (auth)

23034 SENSITIZATION OF ORGANISMS TO RADIATION BY SULFHYDRYL-BINDING AGENTS. Bridges, Bryan A. (Medical Research Council, Harwell, Eng.). Advan. Radiat. Biol.; 3: 123-76(1969).

A review is presented of the role of sulfhydryl-binding agents in sensitization of organisms to radiation. The organisms studied were chiefly bacteria and yeasts. Sensitization of lethal damage by the following agents is discussed: the N-ethylmaleimide group, the iodoacetic group, the mercuric group, vitamin K derivatives, quinones, hydroquinones, sulfurous acid, and nitric oxide. Sensitization of end points other than killing is discussed with regard to genetic damage and physiological damage. The following hypothetical mechanisms of action are discussed: removal of natural intracellular protective substances; interference with cellular repair capacity; reaction of sensitizer with transient lesion on macromolecule; stabilization of free radical center; and release of toxic products from halogen-containing compounds. (H.L.W.)

Radiation Effects on Plants (External Source)

Refer also to abstracts 22943, 22946–22950, 22952–22961, 23006, 23019, 23130, and 23167.

23035 (KURRI-TR-84, pp 68-71) MOLECULAR MECHANISM OF RECOVERY IN PLANTS. Yamaguchi, Hikoyuki; Yamamoto, Koji (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

A trial was conducted to determine the repair of chromosomal

breaks after irradiation by the change in the number of chromosomes or their separate fragments that appear in cells at a later period. Germinant seeds of barley were exposed to gamma radiation when the cells in the meristem of its root tip were in phases G_1 and G_2. Various time intervals were established between irradiation and centrifugation. It was known that among chromosomal breaks produced in the G_1 phase, there were some that were recovered for the first time in the S phase. Among G_2 cells, within about 20 minutes the chromosomal breaks were recovered and it was pointed out that DNA compounds were necessary for this recovery. It is clear that after irradiation, the time for repair mechanism of chromosomal damage to activate varies in each phase of the cell cycles. Most of chromosomal breaks produced by irradiation rejoin and recover soon after the irradiation. When the breaks rejoin in an original form, there occurs no chromosomal aberration, but when they rejoin in a combination different from the original, or rejoin with the sections of neighboring chromosomes, there will be change-type aberration. When the breaks remain as they broke and without any original bodies, they become chromosomal (branch) fragments. It is known that about 99% of the breaks due to irradiation are repaired. It is known for microspores of spiderwort or root tips of horse bean or barley, that centrifugation given right after or during irradiation increases the frequency of occurrence of chromosomal aberration. This is explained by the fact that until the repair of chromosomal breaks, sections of chromosomes are separate from each other due to the physical condensation or movement caused by centrifugation. Therefore, it is possible to determine how long the chromosomal breaks produced by irradiation take to recover by applying centrifugation at various periods of time after irradiation. (Japan)

23036 MODIFICATION OF THE EFFECT OF THE ACUTE GAMMA IRRADIATION BY ^{60}Co IN HELIANTHUS ANNUUS L. Kovacik, A.; Skalska, R. (Inst. of Genetics and Plant Breeding, Prague). Genet. Slechteni; 7: No. 4, 245-58(Oct 1971). (In Czech).

The influence of different intervals between the irradiation of the seeds and sowing was investigated in sunflowers. During this period, seeds were stored in different temperature conditions. In both varieties employed, the correlation between the dose of radiation and the frequency of changes in the characters studied was stable. Different periods between the irradiation and sowing showed the least influence at the beginning of the vegetation period and at lower doses. Different temperatures of storage showed no influence on mutual differences. The influence of storage temperatures is negligible except the short-time variants of storage at the temperature 25°C. The experiments investigating the influence of acute gamma irradiation on seeds of different ages (1 to 4 years) showed that no relation between radiobiologic effect of irradiation and the age of the seed employed exists, if the given doses of ^{60}Co were used. The results may have a practical importance for choosing optimal conditions of irradiation of the sunflower achenes when desirable mutations are to be induced. (auth)

23037 VEGETATIVE AND CYTOGENETIC CHARACTERISTICS OF LENS ESCULENTA (MOENCH) AFTER IRRADIATION BY FAST NEUTRONS. Uhlik, J. (Agricultural Univ., Prague). Genet. Slechteni; 7: No. 4, 259-68(Oct 1971). (In Czech).

The data obtained concern the evaluation of vegetative characteristics of irradiated plants, and investigation of the cytogenetic effect of the radiation employed. Further, the aim of the experiments was to evaluate the radiation produced by the cyclotron of the Institute for Atomic Energy (Czechoslovak Academy of Sciences) and its suitability for biological purposes. On the basis of experimental data obtained, a comparison of the effect of fast neutrons on the growth and development of plants in the M_1 generation and the cytogenetic efficiency of the mutagen employed could be made. (auth)

23038 CYCLE DEPENDENT VARIATION OF X-RAY EFFECTS ON SYNCHRONOUS MITOSIS AND THYMIDINE KINASE INDUCTION IN PHYSARUM POLYCEPHALUM. Sachsenmaier, W. (Univ., Innsbruck. Deutsche Krebsforschungszentrum, Heidelberg); Bohnert, E.; Clausnizer, B.; Nygaard, O. F. FEBS (Fed. Eur. Biochem. Soc.) Lett.; 10: No. 3, 185-9(Oct 1970).

Investigations were carried out to determine whether a radio-induced delay in mitosis was accompanied by a corresponding change of the time marker for thymidine kinase induction or whether these two events could be dissociated. The cycle dependent variation of the x-ray effects was studied in order to determine the possible mechanism of ionizing radiation. Entire plasmodia or segments were x-irradiated and mitotic stages were observed with a phase contrast microscope. Thymidine kinase activity was determined in the high speed supernatant of plasmodial homogenates. Results indicated that the radiosensitivity of Physarum plasmodia changes drastically during the synchronous nuclear division cycle. The time markers of mitosis and of thymidine kinase induction were equally affected by x-rays suggesting that the control mechanisms of these two events are closely related or identical. (H.L.W.)

23039 SOMATIC MUTATION RATE AT LOW LEVELS OF CHRONIC GAMMA-RAY EXPOSURES IN TRADESCANTIA STAMEN HAIRS. Ichikawa, Sadao (Kyoto Univ.). Jap. J. Genet.; 46: No. 6, 371-81(Dec 1971).

Potted plants of Tradescantia ohiensis (= T. reflexa) were chronically exposed to ^{60}Co gamma-rays at exposure rates of 2.3 to 18.5 R/day (115 to 925 mR/hr) in the gamma field of the National Institute of Radiation Breeding. Other potted plants were placed on the protection earth bank surrounding the gamma field and were exposed to a low level (280 mR/day or 14 mR/hr) of scattering radiation. The genetic effects of these radiation treatments were studied in the stamen hairs (essentially single-meristematic-cell system) at two different periods. Genetic responses to these radiation treatments were clearly observed. Somatic mutation rates increased roughly linearly with increasing daily exposure of gamma rays. The gamma-ray exposure given during hair development induced somatic pink mutations at a rate of 3.36×10^{-4} pink mutant events per hair per R effective exposure. It was estimated that the gamma-ray exposure given during hair development was almost twice as efficient as those given before hair development. The frequency of pink mutant cells in the hair cell population also increased roughly linearly with increasing daily exposure. The frequency per cell per R effective exposure reached the value of 8.78×10^{-5}. More genetic effects than expected were observed in the stamen hairs irradiated with scattering radiation at a very low exposure rate of 280 mR/day at the top of the earth bank of the gamma field. Namely, the mutation rates by this treatment were almost as high as those by 2.3 R/day gamma-ray irradiation in the gamma field. It is suspected that the scattering radiation may have seven to eight times more efficiency than the direct ^{60}Co gamma rays. The stamen hair system of Tradescantia heterozygous for flower color proved to be a sensitive biometrical system for detecting low levels of radiation exposures (e.g., ca. 2 R exposure during hair development plus ca. 2.5 R exposure before hair development at 280 mR/day exposure rate). The present results obtained by using Tradescantia stamen hairs seem to throw doubt on the safety standards for radiation facilities. (auth)

23040 INDUCED CHLOROPHYLL CHIMERAS AND MUTATIONS IN SORGHUM. Sree Ramulu, K. (Agricultural Coll. and Research Inst., Coimbatore, India). Madras Agr. J.; 57: No. 12, 727-32(Dec 1970).

Treatments with X- and gamma rays, and chemical mutagens (ethyl methane sulphonate (EMS), methyl methane sulphonate (MMS), diethyl sulphate (DES)) and combination treatments were given to seeds of three cultivated varieties (CO 11, CO 12 and CO 18) of Eu-Sorghum to study their relative effects in inducing chlorophyll chimeras in M_1 and chlorophyll mutations in M_2 and also to find out the relationship between these two phenomena. A variety of types having chlorophyll deficiency to different degrees was observed. These chlorophyll chimeras were observed only in M_1 plants treated with chemical mutagens and combination treatments. EMS induced the maximum frequency of chimeras as compared to other mutagens. The variety CO 18 responded with higher frequency of chimeras than the other two varieties. The frequency of chimeras increased with an increase in the dosage of radiations keeping the concentration of chemical mutagens constant in the combination treatments. Besides, a linear relationship of chlorophyll mutation frequency with dose of the mutagens, a saturation effect was observed at higher doses. EMS was found to be the most potent mutagen in inducing the chlorophyll mutations as compared to the rest of the mutagens. Combination treatments induced comparatively a higher frequency of mutations than the single treatments. The occurrence of the chlorophyll chimeras specifically in treatments with chemical mutagens and their non-relationship with M_2 chlorophyll mutation frequency suggests the possible reasons to either physiological damage in the growing apices or mutations of the plastic genes in the cytoplasm. (auth) (INIS)

23041 EFFECTS OF IONIZING RADIATION AND PHYTOHORMONES ON THE GERMINATION AND GROWTH OF URAL LICORICE. Kryukova, L. M.; Abdrakhmanov, O. K. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Fiziol. Rast.; 18: No. 5, 1043-5(Sep-Oct 1971). (In Russian).

Air-dried seeds of Ural licorice were subjected to x irradiation, treated with either gibberellic acid or indolylacetic acid, and then

sown. Other groups of licorice seeds received only radiation, only hormone treatment, or neither. Doses of x radiation from 10 to 500 R stimulated seed germination, as determined by actual germination count, as did hormone treatment. A synergistic action was manifest in the case of joint radiation and hormone treatment. (K.S.W.)

23042 INDUCED MUTATIONS AND BARLEY IMPROVEMENT. Gustafsson, Ake; Hagberg, Arne; Persson, Goeran; Wiklund, Kjell (Inst. of Genetics, Lund, Sweden. Swedish Seed Association, Svaloef-Undrom). Theor. Appl. Genet.; 41: No. 6, 239-48(1971).

A review is presented of research on seven barley varieties, originating from three x-ray-induced mutations, that have been officially approved in Sweden since 1958. Criteria for selection of parent varieties for mutation breeding are discussed. The successive improvement and change of Bonus barley and its mutants and experiments on Gull barley are described to illustrate the evaluation of advantageous characters against inferior ones. Experiments on mutation breeding of various barley varieties are discussed with regard to improvement in disease resistance, lodging resistance, straw height, nitrogen preference, earliness, adaptability, productivity, and resistance to straw breakage. The development of favorable hybrid lines using chromosome translocations is described. (H.L.W.)

23043 RADIORESISTANCE OF SOME MICROORGANISMS AND THEIR PURINE-5-PHOSPHORIBOSE-1-PYROPHOSPHATE TRANSFERASE ACTIVITY. Partsch, G.; Altmann, H. (Reactor Center, Seibersdorf, Austria). pp 53-62 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

The molds, Penicillium terrestre, Thinocladiella sp., and Aspergillus versicolor, were isolated from fresh apple juice and cultivated on potato-dextrose agar. The fungi, Pullularia pullulans and Byssochlamys fulva, were also studied. Cell suspensions were exposed to gamma radiation at a dose rate of 450 krad/hr. Activities of purine-5-phosphoribose-1-pyrophosphate transferase were determined in cell-free extracts with the aid of autoradiography. Graphs are presented to show survival curves of the fungi and the effects of radiation dose on the enzyme activities. It was found that enzyme activities varied in different organisms and there was no correlation between radioresistance of the organisms and enzyme activity. (H.L.W.)

23044 U. V. MUTABILITY IN GAMMA-RAY-SENSITIVE MUTANTS OF NEUROSPORA CRASSA. Mehta, R. D.; Weijer, J. (Univ. of Alberta, Edmonton). pp 63-71 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

Three gamma-ray-sensitive mutants were isolated in Neurospora crassa by uv induction. Genetic analysis of these mutants indicated that gamma-ray sensitivity is controlled by a single nuclear gene. Tests for uv sensitivity revealed that the gamma-ray-sensitive mutant gs-6 a, pe is, in addition, sensitive to uv radiation, whereas two other mutants and their progenitor wild type are uv resistant. Ultraviolet mutability tests showed that fewer caffeine-resistant mutants were induced in all the three gamma-ray-sensitive mutants as compared to the wild type when irradiated at the same uv dose levels. The results are discussed in the light of similar data reported in other fungi and bacteria. (auth)

23045 INDUCTION OF AMYLASE-PRODUCING MUTANTS IN ASPERGILLUS OF ORYZAE BY DIFFERENT IRRADIATIONS. Meyrath, J. (Institut fuer Angewandte Mikrobiologie, Vienna); Bahn, M.; Han, H. E.; Altmann, H. pp 137-55 of Radiation and Radioisotopes for Industrial Microorganisms. Vienna; International Atomic Energy Agency (1971).

From Symposium on use of radiation and radioisotopes for industrial microorganisms; Vienna, Austria (29 Mar 1971). See STI/PUB-287; CONF-710341.

Some properties of amylases in general, and of fungal α-amylase in particular, as well as their applications have been elucidated. The different methods of industrial amylase production are compared and attempts are made to explain the different behavior of amylase-producing Aspergillus oryzae under the various methods of cultivation. Attempts have been made to devise a simple screening test on the basis of these observations. The first screening was done by taking the ratio of the diameter of the dissolved starch zone to that of the colony as a measure for specific amylase-producing ability after irradiation with uv rays, gamma rays and fast neutrons. It has been confirmed that high irradiation doses are not particularly suitable for the induction of a relatively large proportion of favorable mutants. While there was a relatively large proportion of promising mutants on these screening plates, the results in actual production tests did not show as high a proportion of enhanced mutants. (auth)

23046 SOME EFFECTS OF LOCALIZED INTERNODE SEGMENT AND ENTIRE-SHOOT X IRRADIATION ON THE SURVIVAL AND MORPHOLOGY OF SUNFLOWER PLANTS. Bankes, David Allen. Columbus, Ohio; Ohio State Univ. (1971). 123p. University Microfilms Order No. 72-4417.

Thesis.

A short segment of first internode or the entire shoot of sunflower plants (Helianthus annus) was x irradiated (0.5 to 7.0 kR). Entire-shoot irradiation caused malformation of leaves, fasciation of stems, inflorescence capitula, increases in the number of stem lesions, and loss of apical dominance. Malformation of leaves was probably caused by cell death in marginal meristems. Fasciation was attributed to cell death in apices. The LD_{100} was 3.5 kR for segment and 2.5 for entire-shoot irradiation. Death following segment irradiation was due to desiccation. Because the LD_{100} values following segment and entire-shoot irradiation were similar, physiological and anatomical events that occur in internodes are probably important with respect to survival. (Diss. Abstr. Int., B)

23047 BEHAVIOR AND TRANSMISSIBILITY OF RADIATION INDUCED RING CHROMOSOMES. Saccardo, F. (CNEN, Rome). Genet. Agr.; 25: No. 1-2, 99-111(30 Jun 1971). (In Italian).

After pollen treatment of Piscum cv. Parvus with x rays (750 R), a variegated and a chlorina maculata mutants were isolated in M_3. Both the mutants are cytologically characterized by the presence of ring chromosomes. Such ring chromosomes are persistent and transmissible also through male gametes as showed by a back cross analysis. Through the ring chromosome behavior at mitotic anaphase, cells with different genome (2n = 14, 14 + 1 or 2 rings and 2n = 14 + 1 ring + 1 telocentric) can be formed; the ring can also determine a chromosome breakage-fusion-bridge cycle. A mixochimeric structure with a mosaic phenotypic pattern is consequently found in the mutant plants. Between the two mutants, higher percentage of cells with ring chromosomes and of double bridges was found in the variegated mutant probably because of the lower size of the ring chromosome of the chlorina maculata type. Only 4% of trivalent association between ring and homologous chromosomes at methapase I was ascertained in the variegated mutants. In both mutants, a high percentage (75 to 95%) of anaphase I with lagging ring chromosomes and a low percentage (0.5 to 2.5%) of chromatidic bridges were found. In progenies of variegated plants with 2n = 14 + 1 ring, normal (2n = 14), variegated plants (2n = 14 + 1 or 2 rings), trisomics (2n = 15), and partial tetrasomics (2n = 15 + 1 ring) were identified. Aneuploid gametes can be formed either from disjunction of chromosome association at metaphase I or from ring breakage during mitotic cycles. (auth)

23048 INFLUENCE OF AN INDENE COMPOUND P-38 ON THE RATE OF CHROMOSOMAL ABERRATIONS IN CREPIS CAPILLARIS, INDUCED BY GAMMA-RAYS AND FAST NEUTRONS. Eizenberga, V. T.; Freimanis, Ya. F. (Inst. of Biology, Riga. Inst. of Organical Synthesis, Riga). Latv. PSR Zinat. Akad. Vestis; No. 11, 36-40(1971). (In Russian).

The modifying effect of the indene compound P-38 on the rate of cytogenetic damage was studied in meristematic cells of primary radicles in Crepis capillaris. The data show that preparation P-38 is highly effective when applied both before and after irradiation with gamma rays in doses of 10 and 20 kR. In combination with neutron irradiation, the treatment of seeds with a resolution of the preparation exerted a much weaker protective action: a reliable protective effect of the preparation was established at the irradiation dose of 2000 rads only. The maximum dose of gamma rays (40 kR) and fast neutrons (4000 rad) favored the suppression of mitosis in meristematic cells of primary radicles, on account of which the action of the preparation P-38 at higher doses was not determined. (auth)

23049 METABOLIC CHANGES INDUCED BY SPROUT INHIBITING DOSE OF γ-IRRADIATION IN POTATOES. Kodenchery, Ussuf K.; Nair, Madhusudanan P. (Bhabha Atomic Research Centre, Trombay, India). J. Agr. Food Chem.; 20: No. 2, 282-5 (Mar-Apr 1972).

The respiration studies after irradiating potatoes at doses of 0, 5, 10, 25, 50, 100, 200, and 500 krad showed maximum CO_2 output at 10 krad except at higher doses like 200 and 500 krad.

The respiratory quotient was 1, in all cases. A 25% increase in starch phosphorylase noted 2 h after irradiation persisted even at 24 h. But in the case of 500 krad, about 10% inhibition was observed at 24 hr. A 12% increase in reducing sugar content was obtained at 10 krad. Incorporation of 2-^{14}C-acetate into organic acids at 4 and 24 h after irradiation revealed that the radioactivity in major organic acids, citric and malic, was much higher at 4 h in irradiated sample, and at 24 h the radioactivity was less than that in control. Studies of free amino acids showed an increase in aspartic acid, asparagine, threonine, serine, alanine, isoleucine, leucine, lysine, and arginine 24 h after irradiation. A decrease was observed in the case of glutamic acid, proline, methionine, and phenylalanine. Radioautography of the free amino acids after 2-^{14}C-acetate incorporation confirmed the above observations. (auth)

23050 POST-IRRADIATION MODULATION OF IONIZING RADIATION DAMAGE TO PLANTS. Klein, Richard M.; Klein, Deana T. (Univ. of Vermont, Burlington. St. Michael's Coll., Winooski, Vt.). Bot. Rev.; 37: No. 4, 397-436(Oct-Dec 1971).

A review is presented of the literature on post-irradiation treatments for modulation of radiation damage to plants. Three classes of treatments, termed division delay, metabolic activation, and redox, are reviewed. The treatment known as division delay includes post-irradiation manipulations that temporarily suppress cellular reproductive processes in order to ameliorate damage. The following methods of inducing division delay are reviewed: inadequate growth media; temperature-induced division delay; chemical suppression of division; ultraviolet radiations; and magnetic fields. The role of metabolic activation in modulation of radiation damage is reviewed with regard to intermediary metabolism, nucleic acid and protein synthesis, inorganic ions, and plant growth regulators. Any manipulation that can affect the oxidation and reduction potential at a given cellular site is known as redox and this method of modulating radiation damage is divided into four operational groupings: heat shock, oxidation-reduction agents, visible radiations, and transmission to unirradiated tissues. (approximately 350 references) (H.L.W.)

Radiation Effects on Animals (External Source)

Refer also to abstracts 24633, 24645, and 24648.

23051 (KURRI-TR-84, pp 1-6) RADIATION EFFECTS ON LIVING ORGANISMS AND ITS RECOVERY. INTRODUCTION AND OBSERVATION BY A SOCIETY FOR THE STUDY. Takebe, Hiraku (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

Regarding the essence of radiation injuries, in order to decide the radiation effects on living organisms, it can be explained by the target theory by which targets inside the cells of organisms are thought to be hit. The target is DNA. An important assumption of the theory is that the type of hit is either complete or nothing and there is no intermediate type. Regarding the change of DNA by the influence of radiation, pyrimidine dimer which is thought to be the product of uv injury (injury by ultraviolet) was a clue encouraging research of the mechanism of recovery. There are many points to be solved regarding the product of DNA injury caused by ionizing radiations like x rays and γ rays, but breaking the DNA strands is thought to be a cause of the lethal effect in the case of E. coli and bacteriophage. Regarding higher animals, the cause has not been decided yet. Regarding the recovery from radiation injuries, photorecovery is an important phenomenon for microorganisms at present. DNA polymerase is known as an enzyme for photorecovery. As a high radiosensitive mutant, xeroderma pigmentosum was discovered. Thus it was proved that the results of the research performed using microorganisms could be applied to the higher living creatures including men. It is thought that in the future if such a mutant of culture cell level as Rec$^-$, which was found in microorganisms and in which genetic recombination is impossible was available, research on x-ray injuries would make rapid progress. (Japan)

Man

Refer also to abstracts 22980, 23006, 24649–24650, and 25031.

23052 (AD-732025) RADIATION EFFECTS IN MAN: MANIFESTATIONS AND THERAPEUTIC EFFORTS. Annual Report, May 1, 1969–April 30, 1970. Saenger, Eugene L.; Silberstein, Edward B.; Aron, Bernard S.; Horwitz, Harry; Kereiakes, James G. (Cincinnati Univ., Ohio. Coll. of Medicine). Dec 1970. Contract DASA01-69-C-0131. 91p. (DASA-2599). NTIS.

The goal of the program has been to obtain new information regarding the pathophysiologic, psychologic, immunologic, hematologic, and biochemical effects of total- and partial-body irradiation in human beings. Irradiated patients all of whom have inoperable, metastatic carcinoma but are in relatively good health, provide the opportunity to study multiple facets of the effects of radiation in man rather than in experimental animal. The extrapolation of results from laboratory animals to man is fraught with error. Biochemical and psychological studies have extended the findings of previous report in depth and scope. Several new biological dosimeters are under evaluation. (auth) (USGRDR)

23053 (AECL-4075) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, JULY 1–SEPTEMBER 30, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec 1971. 56p. (PR-B-91). Dep. NTIS (U. S. Sales Only). AECL $1.50.

Sixteen brief abstracts are presented of progress in the following areas of research in the Biology Branch: radiation damage to DNA of bacteria, bacteriophages, and yeasts; radiation genetics of insects; and radioinduced leukemia in rats. Eight abstracts are presented from the Population Research Branch describing progress in research on low dose radioinduced hereditary changes in fish. Data on somatic and genetic damage in human populations are being accumulated by linked files of vital and health records. Thirteen abstracts are presented from the Environmental Research Branch describing progress in research on off-site monitoring; gamma analysis of environmental samples; the fate of radionuclides in aquatic communities; Perch Lake Basin studies; and St. Lawrence River studies. Fifteen abstracts are presented on the following areas of research in the Health Physics Branch: Monte Carlo calculations of fast neutron spectra; thermoluminescent dosimeters; tritium-in-air monitoring; detection of iodine in air; and research on instrumentation. (H.L.W.)

23054 (AED-CONF-71-100-51) RESULTS OF BIOPHYSICAL AND CLINICAL EXAMINATION OF THOROTRAST PATIENTS AND THEIR IMPORTANCE FOR BETTER KNOWLEDGE ABOUT RADIATION LATE EFFECTS. Muth, H. (Universitaet des Saarlandes, Homburg (West Germany). Institut fuer Biophysics); Heyder, J.; Kaick, G. v.; (and others). May 1971. 19p. (CONF-710901-537). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The evaluation of the dose rate from deposits of thorotrast within the human body is complicated by the different metabolic behavior of the thorium daughters, as well as by purely physical parameters such as distribution of the activities at the time of injection between the phases of thorotrast (particle and soluble fraction) in vitro. Animal experiments were done in order to study the variation with time of both the distribution of ^{232}Th and its daughters and the activity ratios between the radionuclides of the thorium decay chain in organs of the reticuloendothelial system (RES) and in marrow-free bone. The segregation of thorium daughters in the colloidal suspension was studied experimentally and compared to the results of theoretical investigations. Male rabbits were injected with 2 cm^3 of thorotrast into the ear vein. From measurements of the activity ratios between ^{228}Ra and ^{232}Th, and ^{228}Th and ^{232}Th, respectively, the age of the suspensions (time between manufacture and injection) was calculated to be 3.5 years. The time of thorotrast burden varied between 0.125 and 530 days. Besides measurements on clearance from blood and on whole body retention of ^{232}Th and daughters the following investigations were done for reasons of dosimetry: experimental and theoretical determination of the activity ratios between thorium daughters in the different phases of thorotrast in vitro (particle and soluble fraction); determination of variation with time of the activity ratios between thorium daughters in the organs of the RES; measurements of retention by the marrow-free skeleton of ^{228}Ra and ^{224}Ra in ionic form at the time of injection; measurements of the translocation of ^{228}Ra and ^{224}Ra in ionic form from the RES to marrow-free skeleton and elimination of both radium isotopes from the body; comparison of the steady state activity ratios between ^{232}Th and its daughters in thorotrast patients and of those in animals extrapolated to 20 years and more of thorotrast burden; and calculation of the dose rates (α, β, and γ) in the liver, spleen, and total skeleton of thorotrast patients, with special reference to the γ dose rate, which was calculated on the basis of the MIRD dose concept. (C.H.)

23055 (BNWL-SA-4243) PRELIMINARY DATA ON CHROMOSOME ABERRATIONS IN SWINE AND HUMAN LEUKOCYTES WITH A BRIEF REVIEW OF FACTORS AFFECTING THEIR OBSERVED FREQUENCY. Hungate, F. P.; McClanahan, B. J.

(Battelle Pacific Northwest Labs., Richland, Wash.). [1972]. Contract AT(45-1)-1830. 18p. (CONF-720108-1). Dep. NTIS.

From Conference on research animals in medicine; Washington, D. C. (28 Jan 1972).

Preliminary results from a study of relative sensitivities of porcine and human leukocyte chromosomes to x-rays suggest that aberration frequencies are slightly greater in human cells. Data are also reported for $^{90}Sr-^{90}Y$ irradiation of swine leukocytes but comparable results of tests with human cells are not yet available. Radiation dose and dose rate, quality of radiation as measured by linear energy transfer, and the modifying factors, oxygen and virus, are briefly discussed for their general role in modifying the frequency of aberrations observed following radiation exposure. (auth)

23056 (CEA-CONF-1943) MICRODOSIMETRY AND THE FORMATION OF DICENTRIC CHROMOSOMES IN IN VITRO IRRADIATED LYMPHOCYTES. Chmelevsky, D.; Chemtob, M.; Parmentier, N. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 31p. (In French). (CONF-711028-2). Dep. NTIS (U. S. Sales Only).

From third symposium on microdosimetry; Stresa, Italy (17 Oct 1971).

Important experimental research was conducted on chromosome aberrations, in order to establish a dose-effect relation, for different types of radiation. The aim of the experiments was to obtain the basic information necessary for biological dosimetry in the case of an accident. The results of this research enabled the number of dicentric chromosomes per cell in human blood to be determined after in vitro irradiation with ^{60}Co γ radiation, and a mixed neutron γ ray flux, and in addition the same parameter for the blood of pigs after in vitro ^{60}Co irradiation. (France)

23057 (KURRI-TR-84, pp 53-67) RADIATION DAMAGE AND ITS REPAIR IN THE CHROMOSOMES OF HUMAN LYMPHOCYTES. Sasaki, M. S. (Kyoto Univ. (Japan). Research Reactor Inst.).

From Meeting on recovery of radiation injuries; Osaka, Japan (4 Aug 1970).

From the cytological data on the production of radiation-induced chromosome aberrations in human lymphocytes, an attempt has been made to take an insight into the possible nature of the primary damage that results in the formation of chromosome structural change and some controlling factors involved in the repair of the radiation damage. The cytological data were consistent with the ideas that chromosome constitutes possibly a single continuity of DNA molecules, primary damage resulting in the chromosome structural change is that produced on the chromosomal DNA, exchange aberration comes from an interaction of two reparable damages each produced by an energy loss of about 100 eV when they are formed within a spatial proximity of the order of 0.2μ, and terminal deletion comes from the irreparable damage. (auth)

23058 (STI/PUB-21/40) NEUTRONS IN RADIATION BIOLOGY AND THERAPY. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 871p. IAEA $24.00.

Abstracts of over 2500 articles published in the world literature from 1935 through 1970 on the biological effects of neutrons and uses of neutrons in therapy are presented. Author, CATEL, CATIN, and KWICAT keyword indexes are included. (C.H.)

23059 (SZS-14/71 (pp 15-25) MAXIMUM PERMISSIBLE VALUES OF INTERNAL RADIATION BURDEN FROM ^{125}I. Strauss, H.; Muenchow, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

On the basis of computationally assessed values of the MPC of iodine-125 in air and water maximum permissible values of the internal radiation exposure were derived. These values are the basis for routine radiation protection measures and control measures during handling this radionuclide. The computation was performed according to the methods provided by the ICRP and parameters taken from literature. (auth)

23060 (TID-25909) RADIOCHEMICAL AND RADIOECOLOGICAL STUDIES ON BRAZILIAN AREAS OF HIGH NATURAL RADIATION. Work in Progress and Scientific Results, January-October 1971. Barcinski, Marcello Andre (Universidade Federal do Rio de Janeiro (Brazil). Instituto de Biofisica). 1971. Contract AT(30-1)-3273. 8p. Dep. NTIS.

Guarapary is a town of about 10,000 inhabitants located on the Atlantic coast, State of Espirito Santo, Brazil. The soil contains appreciable amounts of Th and U that result in a high level of natural background radiation. Ordinary street levels of radiation range between 0.05 and 0.2 mR/h and levels up to 0.6 mR/h are found in houses. Preliminary results are reported from a survey of the number of chromosome aberrations found in cultured lymphocytes of peripheral blood samples from the inhabitants of Guarapary compared with inhabitants of an area with normal background radiation. A comparison of the number and type of aberrations showed a statistically significant difference between the Guarapary and control groups. (C.H.)

23061 (UCRL-Trans-10570) THIRD REPORT ON THE INVESTIGATION INTO THE ACTUAL CONDITION OF IRRADIATED PERSONS IN YAMAGUCHI PREFECTURE. Chikazawa, Kei'ichi; Funazu, Ei; Yamaguchi, Hisromitsu. Translated for Univ. of California, from Collect. Treatises Fac. Hum., Univ. Fukuoka; 2: No. 4, 871-(Mar 1971). 62p. Dep. NTIS.

Data are summarized from a 1969 survey on the health status of residents of Hiroshima and Nagasaki exposed to radiation from the atomic bombing in 1945 and the health status of their offspring. The results show that more than 80% of the exposed persons have a history of illnesses which adversely affected their health. Persons exposed indirectly to radiation have experienced more illnesses than persons exposed directly. Gastrointestinal disorders and hepatitis were the predominant disorders found, followed by leukemia, pneumonia, bronchitis, and appendicitis. Of the second generation 4% had some infirmity and 5% suffered from lassitude. There appeared to be a direct relation between the health of the parents and that of their offspring, and the first child born to irradiated parents was medically worse off than subsequent children. Data on the health status of children born to irradiated parents are classified by sex, age, estimated radiation dose and dose rate received by the parents, and other factors, including the psychological effects of the radiation history. (C.H.)

23062 MEDICAL X-RAY EXPOSURE AMONG HIROSHIMA AND NAGASAKI A-BOMB SURVIVORS. Russell, W. J. (Atomic Bomb Casualty Commission, Hiroshima). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 10, 12-54(Jan 1971).

Medical x-ray exposure was studied as a possible complication in the long-term evaluations of A-bomb survivors for late radiation effects. Participants in the Atomic Bomb Casualty Commission (ABCC)-Japanese National Institute of Health of the Ministry of Health and Welfare (JNIH) Adult Health Study were the focus for these investigations. An average of 23% of Hiroshima and 12% of Nagasaki Adult Health Study subjects received x-ray examinations in other institutions during the 3 months preceding their visits to ABCC. Medical x-ray examinations were significantly more frequent among A-bomb survivors than comparison subjects in the Adult Health Study, but not to an extent to cause bias between these two categories. The magnitude of cumulated medical x-ray doses approximated that of the A-bomb at distances from the hypocenters of 2200 meters in Hiroshima and 3200 meters in Nagasaki. ABCC x-ray examination doses were calculated for each Adult Health Study subject, and routinely updated with each examination for comparison with each subject's A-bomb dose. Each subject's exposures to fluoroscopy, photofluorography and radiation therapy in other hospitals are recorded for future reference. Activity of radiologic practice in Hiroshima and Nagasaki increased steadily since 1948, and was markedly different in the two cities. For the years 1946 to 63 the bone marrow integral dose was 1269 and 454 g-rad in Hiroshima and Nagasaki respectively. Gonadal doses were 118 and 37.4 mrad for males and 1652 and 413 mrad for females of Hiroshima and Nagasaki respectively. Corresponding skin doses were 43.5 and 12.8 rad for the two cities respectively. (auth) (Japan)

23063 HERPES ZOSTER IN HODGKIN'S DISEASE. Wilson, J. Frank; Marsa, Gerald W.; Johnson, Ralph E. (National Cancer Inst., Bethesda, Md.). Cancer; 29: No. 2, 461-5(Feb 1972).

In 163 consecutively irradiated patients with Hodgkin's disease, Stage I-III, herpes zoster subsequently occurred in 31 (19%). The incidence of zoster was increased in patients with mixed cellularity histology, Stage III disease, and in those patients with early stages treated with extensive irradiation. The majority of patients developed shingles within six months of primary treatment, a result suggestive of immunosuppression by lymphoma and/or irradiation, and was not associated with a high incidence of relapse. In those whose zoster occurred later than six months following primary therapy, a high incidence of lymphomatous recurrence (10/13) was noted, making herpes zoster an important prognosticator only in these selected individuals. (auth)

23064 EFFECT OF POSTOPERATIVE RADIOTHERAPY ON PERIPHERAL BLOOD LYMPHOCYTES IN PATIENTS WITH CARCINOMA OF THE BREAST. McCredie, John A.; Inch, W. Rodger; Sutherland, Robert M. (Univ. of Western Ontario, London). Cancer; 29: No. 2, 349-56(Feb 1972).

The effect of prophylactic postoperative radiotherapy in patients

with carcinoma of the breast was determined on cells in the peripheral blood. Controls had carcinoma of the breast treated by radical mastectomy. Results were also compared with those in patients with carcinomas of the cervix treated by radiotherapy. None had recurrent disease. Radiotherapy of carcinoma of the breast decreased the total white blood cell count by 15% during the period of the first six months but did not alter the granulocyte count. The total white cell and granulocyte counts did not change in those with carcinoma of the cervix. The lymphocyte count was decreased by one third for 12 months in patients given radiotherapy for carcinoma of the breast and for 24 months in those with carcinoma of the cervix. The lymphopenia persisted in many for 60 months. Function of the lymphocytes was determined by their ability to synthesize nucleic acids when grown in tissue culture with the strong mitogen phytohemagglutinin (PHA). Radiotherapy produced 50% increase in DNA synthesis for 12 months in patients with carcinoma of the breast and for 60 months in those with carcinoma of the cervix. Treatment had no effect on RNA synthesis in patients with carcinoma of the breast but caused a 25% decrease in RNA synthesis for 60 months in those with carcinoma of the cervix. We are unable to explain the prolonged lymphopenia and the decrease in RNA synthesis. Lymphocytes transformed by PHA are mostly thymic-dependent and responsible for cellular immune response. Since the lymphocyte count was decreased by one third and DNA synthesis increased by a greater amount, the number of thymic dependent lymphocytes did not change or may have increased. The cellular immune response to cancer is unlikely to be impaired by local radiotherapy. (auth)

23065 INCIDENCE OF APLASTIC ANEMIA IN A-BOMB SURVIVORS, HIROSHIMA AND NAGASAKI, 1946–1967. Ichimaru, Michito; Ishimaru, Toranosuke; Tsuchimoto, Taiso; Kirshbaum, Jack D. (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Radiat. Res.; 49: No. 2, 461-72(Feb 1972).

Review of the data accumulated at the Atomic Bomb Casualty Commission (ABCC) during the past 20 years revealed 156 cases of aplastic anemia. Forty of these cases were found among atomic bomb (A-bomb) survivors. Analysis of the incidence rate of aplastic anemia among A-bomb survivors was possible, however, on only 11 cases which developed among 79,184 survivors who are in the fixed population under surveillance by ABCC for delayed effects of A-bomb radiation. The period under consideration is from Oct. 1950 to July 1967. The relative risk of aplastic anemia in survivors who received 1 rad or more was 1.8, as compared with those who received less than 1 rad. The number of cases is small and the increase in risk was not statistically significant. Aplastic anemia among A-bomb survivors did not show any particular clinical characteristic. The risk of aplastic anemia among patients treated with radiation and workers exposed to occupational radiation was examined in relation to the results of the present study. (auth)

23066 FAST NEUTRON BEAMS FOR THERAPY. Bewley, D. K. (Medical Research Council, London). Curr. Top. Radiat. Res.; 6: 249-92(1970).

The subject is reviewed under the following topics: production of fast neutron beams; dosimetry of fast neutrons; characteristics of fast neutron beams; and radiobiological factors. (88 references). (E.R.B.)

23067 RADIATION EFFECTS ON THE HUMAN INTESTINAL MUCOSA. Wiernik, George; Plant, Mary (Churchill Hospital, Oxford). Curr. Top. Radiat. Res.; 6: 325-68(1970).

The response of the human intestinal mucosa to therapeutic doses of radiation is reviewed. The conclusions are based on both preliminary animal experiments and clinical investigations. The dynamics of the mucosal epithelium, histological studies, epithelial and goblet cell kinetics, immediate radiation effects, and subsequent radiation changes in the mucosal epithelium are included in the discussion. (92 references). (E.R.B.)

23068 EVALUATION OF THE POST-IRRADIATION QUANTITATIVE CHANGES IN THE CELLS OF THE INTESTINAL EPITHELIUM IN SEGMENTS NOT DIRECTLY STRUCK BY THE BEAM OF RADIATIONS IN PATIENTS IRRADIATED ON THE ABDOMEN. De Dominicis, R.; Arganini, L.; Aulisi, A. (Univ., Florence). Med. Nucl.-Radiobiol. Lat.; 12: No. 2, 123-9(1969). (In Italian).

Variations occurring in the mitotic index and in the number of epithelial cells of the crypts and villi in x irradiated human intestinal loops within and outside the radiation field were evaluated as a function of therapeutic radiation dose (900 to 5000 R). A fall in the mitotic index, but no appreciable deterioration of epithelial cells of the crypts and villi, was observed in all the tissue samples examined. (C.H.)

23069 ACCIDENT DOSIMETRY BY THE USE OF THERMOLUMINESCENT CHARACTERISTICS OF ENVIRONMENTAL SUBSTANCES. Moos, W. S.; Abedin-Zadeh, R.; Haider, J. G. (International Atomic Energy Agency, Vienna). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 719-22(Dec 1971).

The possible use of common building material such as bricks, quartz sand, and concrete for accident dosimetry was investigated. For this purpose their TL characteristics were observed such as glow curves, fading, and dose response. (auth) (UK)

23070 PROPOSED UNIT FOR PATIENT EXPOSURE FROM DIAGNOSTIC X RAYS. Cameron, J. R. (University Hospital, Madison, Wis.). Health Phys.; 21: No. 6, 879-80(Dec 1971).

The roentgen-area-product, (rap), is proposed for use as a unit of patient exposure to diagnostic x rays. The rap is defined as 100 R cm^2. It is suggested that a transmission ionization chamber could be attached to medical x ray units. The charge collected would be an indication of patient radiation exposure and the radiation could be expressed in units of roentgens times the exposed area. A rap-meter for use in fluoroscopy is also suggested. (UK)

23071 DOSIMETRY PROBLEMS IN RADIOTHERAPY WITH HIGH ENERGY ELECTRONS. Dutreix, J. (Institut Gustave Roussy, Villejuif, France). J. Radiol., Electrol., Med. Nucl.; 52: No. 10, 569-74(Oct 1971). (In French).

The depth dose and the basic isodose curves were determined for high energy electrons (20 MeV). Technical problems encountered in the dosimetry of an electron beam are discussed. Corrections to the basic isodose curves when the surface is irregular and the nature of the tissue heterogeneous are considered. Electron beams have remarkable characteristics when used to irradiate superficial or semi-deep tumors. High energy photon beams are, however, much more effective for treating deep cancerous tumors. The use of combined electron beams is more limited in its applications than the use of combined photon beams. (France)

23072 RADIATION HYGIENE IN CZECHOSLOVAKIA. Pavlyukov, E. A. (Inst. of Biophysics, Moscow). Gig. Sanit.; No. 9, 88-90(Sep 1971). (In Russian).

The Center of Radiation Hygiene Information in Czechoslovakia publishes a periodical, Radiohygiene Index, a bibliographical listing of all published papers on radiation effects on public health. Primary and secondary information sources are treated in a summary of material covered, and a brief description of the information-handling procedure with a computer is given. (K.S.W.)

23073 POSTIRRADIATION PROTOCOLITIS. Altaras, J.; Novak, J.; Dimcev, I. (Univ., Giessen, Ger. Inst. of Radiology and Oncology, Skopje, Yugoslavia). God. Zb. Med. Fak. Skopje; 16: 97-102(1970). (In Croatian).

A systematic program of radiographic examination of the intestine was conducted on more than 100 patients who had undergone radiation therapy (doses of 20,000 to 30,000 R γ) for colon carcinoma. About 50% showed signs of acute proctocolitis, but a positive diagnosis could be made for only about one-fourth of the cases. Radiation reactions in the rectum and the sigmoid colon were found more frequently than previously suspected. As a result of radiation therapy, eight severe injuries of the sigmoid colon and three severe injuries of the rectum were found in the group of patients. It was difficult to resolve the differences in diagnosis between a malignant infiltration and radiation injury of the intestine. Based on the findings, all roentgenographically obscure cases of intestinal damage are regarded as radioinduced until proved otherwise. (tr-auth)

23074 RADIATION THERAPY IN CANCER MANAGEMENT. Buschke, Franz; Parker, Robert G. New York; Grune and Stratton, Inc. (1972). 411p. $19.00.

The fundamentals governing the radiotherapy of neoplasms are reviewed. Neoplasms are grouped as to anatomical site and the etiology, clinical features, pathology, treatment, biological effects of treatment, and prognosis of each are discussed in detail. (C.H.)

23075 COMPLICATIONS OF IRRADIATION FOR MAMMARY CARCINOMA. Ozarda, Ahsen T. (Univ. of Missouri, Columbia). S. Med. J.; 65: No. 3, 369-70(Mar 1972).

Extensive skin atrophy and edema were observed in a patient following therapy involving x irradiation of the entire right hemithorax, shoulder girdle, cervical spine, upper ribs, scapula, clavicle, and the skin of the right chest wall. Rare unilateral chondroradionecrosis of the trachea was also demonstrated. Possible causative factors are discussed. (auth)

23076 RADIATION AND AGING. Warren, Shields (Harvard Medical School, Boston. New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. Bull. N. Y. Acad. Med.; 47: No. 11, 1355-60(Nov 1971). (COO-3777-41).

The relation between exposure to excessive radiation and aging in animals and man is discussed. The role of radioinduced cancer, leukemia, coronary diseases, and other nonspecific lesions in accelerated aging is also examined. Radioinduced mutations in somatic cells may also play a role in the gradual functional deterioration made manifest by the symptoms of senescence. (E.R.B.)

23077 PULMONARY AND SPINAL LOAD DURING IRRADIATION OF OESOPHAGEAL CARCINOMA WITH ^{60}Co-GAMMA RAYS IN STANDING FIELD OR PENDULAR METHOD. Zwicker, H.; Felix, R.; Thelen, M. (Univ., Bonn). Strahlentherapie; 142: No. 4, 403-11(Oct 1971). (In German).

In radiotherapy of esophageal carcinoma with ^{60}Co-gamma rays, according to measurements on the Alderson-phantom, the following differences are found for the contemporaneous load of spinal marrow and lungs, in dependence on the irradiation technique: In irradiation with standing fields, counterlaterally applied from the dorsal and the ventral side, the pulmonary load is minimal; 5 pCi of the maximal dose are measured in a distance of 6 cm, 2.5 pCi in a distance of 9 cm. In contrary, the spinal marrow is loaded with 112 pCi, if the focal dose is set as 100 pCi, and the esophagus is situated in a depth of approximately 12 cm, alike in most patients. In pendular irradiation from ventral, the conditions with regard to the contemporaneous spinal and pulmonary load are more favorable, when the pendulum angle amounts to 90°, a wedge filter of 17.5° is used, and the depth of pendulum axis—because of the emigration of the maximum dose in direction to the surface—is augmented 1.5 cm. With the full tumor dose of 6000 R on the esophagus, the spinal marrow's tolerance dose of 4500 R is not exceeded, the pulmonary load—in comparison with the dorsoventral standing field irradiation—is not higher but for the factor 2. (auth)

23078 RADIATION HAZARD IN INTRA-UTERINE TRANSFUSION. Bevis, D. C. A.; Grech, Paul; Parsons, R. J. (Northern General Hospital, Sheffield, Eng.). Brit. J. Radiol.; 45: No. 531, 193-6(Mar 1972).

The radiation doses given to 20 mothers and foetuses during intra-uterine transfusions for Rh-iso-immunization are assessed. Details are given of the method used for these calculations together with the technique of the procedure, as used in the Northern General Hospital, Sheffield. It is calculated that the average mother received a skin exposure of 3,312 mR during amniography and 3,310 mR during fluoroscopy. For radiography the range was 1,450 mR (Case 8) to 5,230 (Case 14) and for fluoroscopy from 942 mR (Case 5) to 7,795 mR (Case 3). The average foetal dose was assessed at 617 mrads—varying from 247 mrads in Case 5 to 1,117 mrads in Case 3. The sources of error inherent in these calculations are given. It is concluded that the foetal radiation dose in this series is acceptable, although it is probably above 1 rad in several cases. (auth)

23079 NUCLEAR ENERGY. BENEFIT AND HAZARDS. VII. GENETIC RADIATION EFFECTS. VDI (Ver. Deut. Ing.) Nachr.; 25: No. 17, 31(1971). (In German).

When considering all tumors as a whole, the conclusion is that it may come in the following 20 yrs to leukemia and, in contrast to certain statistics, to the same or to a maximum of 5 to 6 times the number of malignant diseases. Nothing supports the concept of the doubling dose on which these statistics are based. Probably only the fraction of 1% of all malignant diseases is induced by natural radiation exposure. For radioiodine, the risk evaluation per rad thyroid dose indicates a rate of 100 cases of cancer among 1 million children, but this value is questionable. In radioinduced malformations there is probably no linear dose response. Proceeding from the most favorable hypothesis, an increase of radiation exposure to 0.15 Rem/y would cause an increase of malformations by 1%. There are only rough estimates of genetic radiation hazards. Proceeding from the most favorable assumption, the spontaneous mutation rate would be doubled by doses from 10 to 100 rads. The factors counting for manifestation of damages are discussed by means of two examples: single high radiation exposure of a limited number of persons; and uniform increase of radiation exposure to 0.15 Rem/y of a closed great population or of the entire mankind respectively. (INIS)

23080 DIAGNOSTIC ABDOMINAL RADIOISOTOPIC LYMPHOGRAPHY AND RADIATION THERAPY. Spreafico, G. L.; Puricelli, G.; Lualdi, M. J. Nucl. Biol. Med.; 15: No. 2, 61-2(Apr-Jun 1971).

Eighty patients with tumors of the genital system, rectum, and lower limbs were examined by radioisotopic lymphography before and after radiocobalt teletherapy or endolymphatic therapy with ^{131}I-Lipiodol in order to evaluate the effectiveness of this diagnostic method for assessing the morphological and functional changes of the inguinal and abdominal lymph nodes during radiotherapy. The scintigraphic maps obtained following the injection of the radiocolloidal gold were also useful in establishing the therapeutic program. (E.R.B.)

23081 COMPARISON OF THE RADIATION DOSES TO THE WRISTS AND FINGERS OF WORKERS ENGAGED ON RADIOCHEMICAL PROCESSING. Chiswell, W. D. (Radiochemical Centre, Amersham, Eng.); Gilboy, W. B. Health Phys.; 22: No. 4, 327-31(Apr 1972).

Measurements were made in order to determine the relationship between wrist and finger doses, and confirm that a wrist dosimeter gives a satisfactory measure of hand doses for the type of work carried out at Radiochemical Centre, Amersham. (auth)

23082 LATE-APPEARING (RADIATION-INDUCED) CARCINOMA. Schindel, Jehuda; Castoriano, Isaac M. (Univ. of Tel Aviv, Petah Tikva, Israel). Arch. Otolaryngol.; 95: No. 3, 205-10(Mar 1972).

In five patients, carcinomata appeared in the postcricoid and hypopharyngeal regions from 7 to 12 years after successful therapeutic irradiation for carcinoma of the endolarynx. These tumors were considered to be radiation-induced. Treatment consisted of cytostatic and palliative drugs in one case, irradiation in two cases, and surgical intervention in two cases. Irradiation appeared to be ineffective in sterilizing the tumor and the treatment of choice in such cases would seem to be surgical. The relevant literature and the problem of etiology are briefly discussed. (auth)

23083 NUCLEAR TRACK RECORDINGS OF THE ASTRONAUTS' RADIATION EXPOSURE ON THE FIRST LUNAR LANDING MISSION APOLLO XI. Schaefer, H. J.; Benton, E. V.; Henke, R. P.; Sullivan, J. J. (Naval Aerospace Medical Research Lab., Pensacola, Fla. Univ. of San Francisco). Radiat. Res.; 49: No. 2, 245-71(Feb 1972).

Small radiation packs containing nuclear emulsions and plastic foil detectors carried by the Apollo XI astronauts furnished a detailed record of the astronauts' radiation exposure. The exposure was found to result mainly from nuclear particles, with electrons and gamma rays contributing only about 15% to the total dose equivalent. A mission dose of 201 mrads corresponding to 402 mrems was found. By far the largest part of the dose was due to trapped protons encountered in two passes of the radiation belt on translunar and trans-Earth injection. Orientation of the plane of orbit to the geomagnetic equator was extremely favorable on both passages, resulting in very peripheral crossings of the inner belt. Mission doses on lunar missions in general, therefore, can be expected to be substantially larger. This has been borne out subsequently by Apollo XIV, which had to go through the core of the inner belt on translunar injection and accumulated a total mission-dose equivalent slightly above 1,000 mrems. (auth)

23084 HUMAN RADIATION CYTOGENETICS. Bender, Michael A. (Oak Ridge National Lab., Tenn.). Advan. Radiat. Biol.; 3: 215-75(1969).

A review is presented of the literature on radioinduced chromosome aberrations and other aspects of human cytogenetics. Chromosome aberrations are discussed with regard to aberration types, dose-effect kinetics, and fates of aberrations. The recent development of new techniques for studying chromosome aberrations induced by in vitro irradiation is reviewed. Aberrations resulting from partial-body, chronic, and fractionated exposures are discussed with regard to exposures to external source and exposures from incorporated radioisotopes. Aberrations resulting from acute, whole-body exposures are discussed with regard to survivors of atomic bombing in Hiroshima and Nagasaki, whole-body therapeutic and diagnostic irradiation, and accidental exposures. In vitro studies on tissue culture cells, peripheral leukocytes, and bone marrow are reviewed. The use of aberration yields for estimating radiation dose is discussed and the advantages and limitations of this type of biological dosimeter are pointed out. A review is presented of studies on estimation of the life span of lymphocytes by measuring the frequencies of chromosome aberrations in blood samples as a function of time following partial body therapeutic irradiation. The use of radioinduced chromosome aberrations for estimating radiation hazards is discussed and the need for population surveys to determine the frequency of transmissible, viable chromosome abnormalities among the offspring of irradiated people is emphasized. (H.L.W.)

23085 REFLECTIONS ON SOME RECENT PROGRESS IN HUMAN RADIOBIOLOGY. Lushbaugh, C. C. (Oak Ridge

Associated Universities, Tenn.). Advan. Radiat. Biol.; 3: 277-314(1969).

Human radiobiology has progressed slowly over the last 10 years, chiefly by the processes of extrapolation from animal experimentation and accretion of clinical observations now being based realistically on depth-dose measurements. As dosimetry for large animals has improved, the dose in critical human organs has been found to be lower than previously imagined, sharply underlining man's great radiosensitivity. Observations of accident victims and patients therapeutically irradiated have produced estimates of known statistical reliability of many of man's dose-response relations. Most recent attempts to estimate his level of radiation-induced lethality appear to agree well and indicate at least that man is not a radioresistant species like mouse. The greatest recent progress in our understanding of his ability to repair radiation-induced damage continues to be derived from generalizations based on animal experimentation, tissue culture, cytology, and cytokinetics. The increasingly excellent studies of this kind on radiation effects in large radiosensitive animals appear to offer the greatest potential for increasing man's understanding of his own radiobiology without putting too much strain on his imagination. (auth)

Vertebrates

Refer also to abstracts 22962 and 23179.

23086 (CEA-N-1498) STUDY OF PLASMA AMINO ACIDS IN PIGS, BEFORE AND AFTER LETHAL IRRADIATION. Valle, Christiane; Pasquier, Christian; Bouin, Paul; Charton, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 18p. (In French). Dep. NTIS (U. S. Sales Only).

The metabolism of plasma amino acids in pigs was studied during the week following a lethal dose of radiation. Very significant increases in the levels of α aminobutyric acid, valine, isoleucine and leucine were observed approximately 17 hours after the irradiation. A threefold increase in the valine, isoleucine and leucine levels and a slightly higher level of the α aminobutyric acid were observed. The levels remained constant until the death of the animals. (France)

23087 (EUR-4764) PATHOGENESIS OF GENETIC AND SOMATIC RADIATION DAMAGE. Annual Report, 1970. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). 1972. 32p. (In German). Dep. NTIS (U. S. Sales Only). EUR BF 50,-.

As part of the research program, experimental studies are being conducted on the frequency and genesis of somatic and genetic radiation damage by exposure to external radiation sources and after the incorporation of radioactive nuclides. The studies deal with selected questions covering the following fields: radiation genetics of vertebrates; functional disturbances of the nervous system after radiation exposure; radiotoxicity; and radiation damage in man resulting from the uptake of ^{224}Ra. (auth)

23088 (NYO-3626-8) EFFECT OF EXPOSURE TO 200 AND 400 R OF IONIZING RADIATION ON THE SURVIVORSHIP CURVES OF THE EASTERN CHIPMUNK (TAMIAS STRIATUS). Tryon, C. A. (Pittsburgh Univ., Pa. Pymatuning Lab. of Ecology); Snyder, D. P. (Massachusetts Univ., Amherst. Dept. of Zoology). [1970]. 19p. (CONF-710501-50). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

The effect of exposure to 200 and 400 R of γ rays on the survival of individual chipmunks is reported. Survivorship curves for exposed chipmunks that were returned to their natural habitat immediately following exposure were significantly higher than those for control groups. The effect is believed to be due to the increased vival of individuals during the early periods of their life and their more rapid disappearance thereafter. (C.H.)

23089 (ORO-2459-379) TRANSPLANTATION IMMUNOLOGY: EFFECT OF RADIATION AND RELATED STUDIES. Progress Report. Hume, David M.; Lee, H. M.; Pierce, James C.; Wolf, James S.; Stickley, Elmer; Newsome, Heber H.; Bell, C. Cooper; Shanfield, Isidore; Sterling, William A. (Medical Coll. of Virginia, Richmond. Strauss Surgical Research Labs.). [1971]. Contract AT(40-1)-2459. 20p. Dep. NTIS.

Research on irradiation of circulating blood included: in vitro studies of lymphocyte reaction to beta irradiation; extracorporeal irradiation studies involving shunt geometry; beta dosimetry; and the biological evaluation of the effects of extracorporeal blood irradiation on blood elements and immunologic responsiveness in the dog and man. Studies were continued on the evaluation of immunologic and metabolic responses to hepatic transplants in the dog and a method for kidney preservation was developed for transplantation studies. In vitro studies of the immune response included: in vitro quantitation of lymphocytes using ^{51}Cr and serum cytotoxic activity following renal homograft rejection in man; kinetic studies of lymphoid tissues in the rat; and detection of isoantigens using ^{51}Cr. Immunologic studies involving the use of antilymphocyte serum included: permanent survival of renal allografts following a limited course of antilymphocyte serum; preparation of antilymphocyte serum; and correlation between immunosuppressive potency and in vitro properties of antilymphocyte serum. Studies were continued on the renin-angiotensin system in patients with renal failure and following renal transplantation. Histocompatibility studies were conducted in relation to immune reactions following renal transplants. Studies on local radiation effects on kidney structures were conducted using narrow beams of x radiation; advantages of the microbeam technique are discussed. (H.L.W.)

23090 EFFECTS OF IRRADIATION ON THE APICAL PORTION OF INCISOR IN RATS. Inomata, Hiroshi (Tohoku Univ., Sendai). Tohoku Igaku Zasshi; 82: No. 6, 331-55(Dec 1970). (In Japanese).

The apical portion of incisor in the upper jaw of a Wistar rat was x-irradiated, avoiding irradiation to hypophysis, and was examined roentgenologically and histologically. Besides its influence on the weight of the tooth, the eruption rate and the eruption mechanism were investigated. Clinical cases, in which teeth or a tooth-germ were irradiated, were also studied. It was suggested that dentin niche and irregular wrinkles in the dentino-enamel junction shown by x-ray were caused by irradiation to a tooth-germ. The weight of a tooth was obviously reduced by x-ray irradiation. With increase of radiation dose, a delay of tooth eruption was observed in the exposed side. It was supposed that delay of incisor eruption by x-ray irradiation was caused by the cellular damage at the apical portion and this delay effect was potentiated by damage of the tissue around the teeth. In the case of a 4-month-old patient, incomplete formation of roots, dwarfed teeth, and disappearance of permanent teeth-germ were observed. In adult teeth, abnormal findings of the alveolar bone and disappearance of the linea alba were observed after four years of exposure. The pulp of teeth was vital in electrodiagnosis. (auth) (Japan)

23091 CONTROL OF HEMOGLOBIN AND RNA SYNTHESIS IN ERYTHROID CELLS FROM MOUSE EMBRYOS. Fantoni, A.; Bordin, S.; Ghiara, L.; Pozzi, L. V. (CNEN, Rome). G. Bot. Ital.; 104: No. 4, 289-302(1970). (RT/BIO(71)11).

Some control mechanisms of RNA and hemoglobin synthesis during the differentiation of erythroid cells are described. The experiments were performed with yolk sac derived erythroid cells from mouse embryos, which form a pure population of cells differentiating in vivo in a homogeneous fashion. The following results are presented: the synthetic capacity for the embryonic hemoglobins E_I, E_{II} and E_{III} change as yolk sac erythroid cells differentiate. The synthesis of these hemoglobins is actinomycin-insensitive and it does not depend on continued messenger-RNA synthesis. The ribosome content is studied in relation to hemoglobin synthesis, thus giving evidence for the hypothesis of a mechanism controlling protein synthesis at the level of translation. Irradiated erythroid cells are no longer capable of cell division, but synthesize hemoglobin at a rate double that of control cells. The content of polyribosomes in irradiated cells is similar to that of control cells. The data indicate that half of the total ribosomes contained in undivided cells are destroyed, while all functional mRNA for hemoglobin is preserved. The kinetics of the passage from nucleus to cytoplasm has been studied for 18 S and 28 S ribosomal RNA, during the differentiation of yolk sac erythroid cells. The data indicate that a larger proportion of nuclear ribosomal RNA is transferred to cytoplasm in older cells than in younger cells, thus giving evidence for a mechanism controlling the rate of transfer of ribosomal RNA from nucleus to cytoplasm in different stages of cell development. (auth)

23092 EXPERIMENTAL STUDIES ON THE RESTORATION OF HEMATOPOIETIC RADIATION INJURY. Mitomo, Yasuharu; Kurokawa, Akira; Asakawa, Mizuho; Takikawa, Kiyoharu Nagoya City Univ., Japan). Nagoya Med. J.; 16: No. 3, 155-64(Feb 1971).

Radiation injury due to 300 R or 600 R of ^{60}Co total body irradiation was investigated on female ddN mice by observing the hematopoietic function. The Pyrexal Test (the T.T.G. Test) after a single total body irradiation revealed that the bone marrow reserve of leucocytes diminished gradually to almost nothing on the fourth day, and then recovered steadily. The previously administered chemicals protected against exhaustion of bone

marrow reserve by the fourth day. Thus, it was confirmed that not only 1-cysteine and mercapto-ethyl-amine (M.E.A.) but also serotonin and 5-hydroxytryptophan (5 HTP) have favorable effects on the hematopoietic radiation injury. It may be concluded from results presented here that the study of bone marrow reserve of leucocytes with the Pyrexal Test (the T.T.G. Test) is more accurate than that of peripheral leucocyte counts for the evaluation of hematopoietic radiation injury. After the single total body exposure with ^{60}Co, evaluation of chemical protective agents against hematopoietic radiation injury with this method was as follows: serotonin, 5 HTP and 1-cysteine; 600 R: slight effect; 300 R: remarkable effect. M.E.A.; 600 R: the most favorable effect of all. S-Adchnon; 300 R: no remarkable effect. (auth)

23093 ACTIVITY OF RAT LIVER ENZYMES RESPONSIBLE FOR GLYCOGEN METABOLISM AFTER WHOLE-BODY IRRADIATION. Catravas, G. N.; McHale, C. G. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Biochim. Biophys. Acta; 252: 285-95(1971).

The activities of liver enzymes involved in the breakdown and synthesis of glycogen have been investigated in this study after whole-body exposure of rats to 1200 rads of x rays or of mixed gamma–neutron radiation. It was found that glycogen phosphorylase and amylo-I, 6-glucosidase (debranching enzyme), both of which are involved in the breakdown of glycogen to glucose units, are inhibited by both qualities of radiation. A considerable inhibition in the activity of amylo-I,4 → I,6 transglucosidase (branching enzyme) was also observed. In contrast, it was found that the activity of UDP glucose–glycogen transglucosylase which is responsible for the in vivo synthesis of I,4-polysaccharides is enhanced whether the animal received x rays or mixed gamma–neutron radiation. Electron micrographs verified the presence of large deposits of glycogen in livers of irradiated rats 48 h after their removal from the exposure room, although no food was given to these animals following irradiation. (auth)

23094 EXAMINATIONS ON EXPERIMENTAL MYCOTIC INFECTIONS OF THE EYES OF RABBITS AFTER WHOLE-BODY IRRADIATION. Gruenewald, H.; Krentel, G.; Langbein, W. (Nationale Volksarmee, Bad Saarow, Ger.). Radiobiol.-Radiother.; 12: No. 5, 623-6(1971). (In German).

Four groups of rabbits were gamma irradiated in doses of 0, 150, 300, and 450 rad. One day later the cornea was inoculated with a suspension of Aspergillus fumigatus conidia. The whole-body irradiation resulted in a dose-related reduction in the leukocyte count of peripheral blood. Experiments of other investigators showed that a reduction of the corneal sensitivity following irradiation or cortisone treatment resulted in establishment of Aspergillus infections. In the present experiments the inoculation of Aspergillus did not succeed in producing infection. (H.L.W.)

23095 EFFECT OF MARROW HOMOTRANSPLANTATION ON INTENSITY OF THE PENTOSEPHOSPHATE CYCLE REACTIONS AND LIFETIME OF ERYTHROCYTES IN ANIMALS WITH ACUTE RADIATION INJURY. Voronkova, N. A.; Shamrai, A. E. (Research Inst. of Roentgenradiology and Oncology, Kiev. Research Inst. of Hematology and Blood Transfusion, Kiev). Ukr. Biokhim. Zh.; 43: No. 6, 738-41(Nov-Dec 1971). (In Ukrainian).

Intensity of the pentosephosphate cycle reactions and lifetime of erythrocytes in rabbits and rats irradiated lethally as well as the effect of marrow homotransplantation on them were studied. Ionizing radiation is shown to evoke in them shortening in the half-life of erythrocytes and disturbances in the pentosephosphate cycle reactions. Under the effect of marrow homotransplantation the metabolic processes in erythrocytes are activated and their half-life becomes normal. The disturbances in the pentosephosphate cycle might be one of the reasons for the intensive destruction of erythrocytes under the effect of ionizing radiation in lethal doses. (auth)

23096 METABOLISM OF HISTONES IN ORGANS OF IRRADIATED RATS. Paskevich, I. F.; Ishkhanova, M. A.; Likhodid, V. S.; Paskevich, L. V. (Inst. of Medical Radiology, Kharkov). Ukr. Biokhim. Zh.; 43: No. 6, 692-6(Nov-Dec 1971). (In Ukrainian).

Biosynthesis of liver and spleen histones was studied in albino rats 2, 24, 48, 72, 96 and 120 hrs after irradiation in a dose of 800 R. It is established that irradiation intensifies synthesis of histones in the liver during the first three days of the experiment, then the specific radioactivity decreases to the control level. In the spleen irradiation inhibits incorporation of labelled precursors into the fractions of histones in all periods of the experiment. In both organs intensity of synthesis of the lysine fraction of the histone is changed more abruptly in comparison with the arginine one. (auth)

23097 RADIOPROTECTIVE EFFECT OF ISOPENTENYLADENOSINE IN MICE. Prasad, N.; Bushong, S. C.; Barton, H. L. (Baylor Coll. of Medicine, Houston. Veterans Administration Hospital, Houston). Experientia; 27: No. 11, 1332-3(15 Nov 1971).

Following intraperitoneal injection of various doses of isopentenyladenosine mice were exposed to 830 rads of ^{60}Co gamma radiation at a dose rate of 34.5 rads/min. The tabulated results show that mean survival time was increased by nearly a factor of two at intermediate doses (0.01 to 0.05 $\mu g/g$) of the compound. Neither a low dose nor a high dose provided significant radioprotection. (H.L.W.)

23098 COMPARATIVE EXAMINATIONS OF THE INFLUENCE OF LONG-LASTING ADMINISTRATION OF E. COLI ENDOTOXIN AND WHOLE-BODY GAMMA-IRRADIATION ON THE DEVELOPMENT OF THE HEMORRHAGIC SYNDROME IN GUINEA PIGS. Volodin, V. M.; Oyvin, V. I.; Tokarev, O. Yu.; Gumenyuk, L. I. Radiobiol.-Radiother.; 12: No. 5, 633-9(1971). (In German).

Experiments with prolonged administration of endotoxin of Escherichia coli were made in order to cause a haemorrhagic diathesis in guinea pigs and to compare the development and the course of haemorrhagic symptoms which appear in these animals after a whole-body gamma-irradiation. The results of the clinical, laboratory and pathological-anatomical examinations do not show similarities between the irradiated animals and those who had received long-lasting administration of E. coli endotoxin. Whereas in the irradiated guinea pigs in the period of the climax of the radiation disease a pronounced haemorrhagic syndrome was found a haemorrhagic diathesis did not develop in those animals who had received endotoxins over a longer period. The results do not indicate that autoinfection and the attendant intoxication of the organism by endotoxins of gram-negative bacteria are the main cause of the development of haemorrhage. (auth)

23099 RADIOPROTECTIVE EFFECT OF KARAGININE ON THE BLOOD-FORMING AND LYMPHOID TISSUES. Chertkov, K. S.; Trushina, M. N.; Chramchenkova, S. P.; (and others). Radiobiol.-Radiother.; 12: No. 5, 649-58(1971). (In German).

The injection of karaginine, a polysaccharide, 10 to 15 min before a minimum lethal dose of gamma radiation protected 60 to 70% of mice against death. Twenty-four hrs after irradiation the number of nucleated cells in bone marrow of protected mice exceeded that in control mice by a factor of 1.7 and 48 hrs after irradiation, by a factor of 2.8. Evaluation of myelograms showed that karaginine had a protective effect on differentiating as well as proliferating cells. The protective index, or percentage value of protected stem cells, proved an adequate test for the protective effect since the protection of colony-forming cells or stem cells plays a determinant part in the repair process of blood formation and consequently the fate of the irradiated organism. (H.L.W.)

23100 ELECTROPHORETIC BEHAVIOUR OF LIVER AND HEART ACETYLCHOLINESTERASE AND MALIC ACID DEHYDROGENASE IN THE PAN-IRRADIATED RAT. Pallavicini, Enrico Bobbio; Pallavicini, Franco Bobbio; Marciano, Salvatore; Scaglione, Pietro; Maineri, Luigi (Univ., Pavia, Italy). Radiol. Med.; 57: No. 3, 210-16(Mar 1971). (In Italian).

Electrophoretic changes in liver and heart acetylcholinesterase and malic acid dehydrogenase observed in the albino rat following total body irradiation with 50 R for 12 and for 24 days are described. (auth)

23101 REMOTE AFTER-EFFECTS OF A JOINT ACTION OF EXTERNAL AND INTERNAL RADIATION SOURCES. Zapolskaya, N. A.; Fedorova, A. V.; Lavrent'ev, L. N. (Leningrad Scientific Research Inst.). Gig. Sanit.; No. 7, 53-7(Jul 1971). (In Russian).

White rats were given 300 R doses of x radiation, or 2μCi of a mixture of radioactive alkaline earths and rare earths. It was found that the combined effects of external and internal radiation were more pronounced than the effects from one source only. If the total accumulated dose from internal radiation sources exceeded the dose from external sources the entire complex of delayed effects was determined by internal radiation. (H.L.W.)

23102 QUANTITATIVE EXAMINATION OF THE RADIATION DAMAGE OF THE SKIN OF MICE. Svyatuchin, M. V.; Karnauchova, E. N.; Letov, V. N. (Inst. for Experimental and Clinical Oncology, Moscow). Radiobiol.-Radiother.; 12: No. 5, 611-21 (1971). (In German).

A method for the quantitative evaluation of the experimental radiation damage of the skin is presented. It is based on the examination of the statistical distribution of the hair follicles according to the intensity of their changes in preparations of irradiated skin. The method makes it possible to determine a 1.5 to 2-fold change of the extent of the radiation damage. In a sufficient number of observations and with an adequate experimental arrangement much smaller changes may be observed, too. Local irradiation of the femoral skin of the experimental mice was done with an X-ray-apparatus of 180 and 30 kv, respectively, and with proton beams of 180 MeV, and the influence of chrysomallin (antibiotic of the group of actinomycins) was studied. It is shown that a decrease of the radiation damage of the skin appears with fractionated irradiation and under the influence of a noradrenalin solution on the irradiated area. Following the use of therapeutical doses of chrysomallin and a dose of prednisolone which causes a retarded growth of the Harding–Passey melanoma a 1.5 to 2 fold increase of the radiation damage of the skin was observed. Toxic doses of chrysomallin increased the coefficient up to 5-fold. (auth)

23103 MORTALITY OF MALLARDS EXPOSED TO GAMMA RADIATION. Abraham, Richard L. (Univ. of Minnesota, Minneapolis). Radiat. Res.; 49: No. 2, 322-7(Feb 1972).

An $LD_{50(30)}$ level of 704 R was calculated for 4-month-old captive mallards. Fifty-five percent of all deaths occurred within the first 16 hours postirradiation. All deaths occurred within 18 days postirradiation. Comparison was made in the rate of dying and the number of deaths between two groups of young game-farm and old wild-caught mallards both given equal high doses of radiation. The percentage of deaths was similar in both groups, but the younger mallards died at a slightly faster rate. (auth)

23104 ELECTROPHYSIOLOGIC RESPONSES OF SCIATIC NERVES EXPOSED TO 200-kV X-RAYS AND 47.5-MeV PROTONS. Gaffey, C. T. (Univ. of California, Berkeley). Advan. Biol. Med. Phys.; 13: 351-71(1970). (CONF-690841-6).

From third international biophysics congress; Cambridge, Mass. (29 Aug 1969).

Electrophysiologic techniques were used to determine the effects of exposing isolated frog sciatic nerves to 200-kV x-rays and 47-5-MeV protons. In distinction to the reports of others, no significant changes were observed in the maximal action potentials or the maximal stimulus strength of nerves exposed to 100 kR of x-rays or 200 krad of protons. Neural activity in nerves exposed to moderate doses of radiation (17.5 krad of protons and 20 kR of x-rays) survived many hours before suffering the loss of impulse transmission. Nerves administered 300 kR of x-rays and 600 krad of protons exhibited an immediate block in conduction. Between these high and moderate doses, the postirradiation time for the inhibition of impulse propagation was an inverse function of the logarithm of the irradiation dose both for x-rays and protons. This relationship indicates that radiation damage is stored in neural membranes. The relative refractory period was found to be the most sensitive electrophysiologic index of radiation damage. Action potentials during the earliest portion of the relative refractory period were impaired by 1–2 kR of x-rays. This indicates that radiation acts initially on the recovery process in neural membranes. The duration of the maximal action potential was increased by 10–20 kR of x-rays in contrast to the latent period which required about 70 kR of x-rays in order to be altered. Changes in the amplitude of the MAP were insensitive to doses below 100 kR of x-ray and 200 krad of protons. The amplitude of the submaximal action potential of nerves showed variable responses to low doses of irradiation. Some of the nerves (59.3%) exhibited no changes in the submaximal action potential with radiation; others increased (33.3%), and a few (7.4%) decreased. The claim by others that irradiation only increases the amplitude of the submaximal action potential is in conflict with the information in this report. It is concluded that irradiation provoked a disturbance in the steady-state condition of neural membranes.. It was found that species of radiation with high linear energy transfer (LET) values have high relative biological effectiveness (RBE) in blocking neural transmission. The notion that LET quotients can be used in a manner similar to RBE ratios has been found useful. (auth)

23105 PRENATAL CHEMICAL PROTECTION AGAINST RADIATION-INDUCED LEARNING DEFICIENCIES. Roberts, Joan M. (Univ. of Detroit). Radiat. Res.; 49: No. 2, 311-21 (Feb 1972).

Cysteamine (β-mercaptoethylamine) was injected into pregnant rats on the 16th day of gestation. They were then irradiated with 185, 110, 50, or 0 R. Four additional groups received the same radiation treatments but were not given cysteamine prior to irradiation. When the offspring of these animals reached adulthood, they were randomly selected to be tested for learning ability in a Lashley III maze where either escape from water or food reinforcement was the motivating factor. In the water maze, there was an inverse relationship between learning ability and radiation dose level with the highest radiation dose resulting in the poorest maze performance. In the irradiated groups that did not receive cysteamine there was an even greater reduction in learning ability and the dose-dependent relationship was much more evident. Where food was the motivating factor, an inverse relationship was found between radiation dose rate and percent survival on the food-deprivation schedule. This was more marked in the groups that did not receive cysteamine prior to irradiation. The survivors did not differ in their maze performance. Deficiencies, mental and physical, that become manifest in the adult as a result of prenatal irradiation can be prevented by chemical treatment of the maternal organism during pregnancy. (auth)

23106 SYNERGISTIC EFFECT OF MITOMYCIN C AND RADIATION ON EMBRYONIC LITTER SIZE REDUCTION IN MICE. Ehling, U. H. (Gesellschaft fuer Strahlen- und Umweltforschung, Munich). Mutat. Res.; 13: No. 4, 433-6 (Dec 1971).

Eighty male mice were divided into four equal groups. The first group served as a control; the second received mitomycin C; the third received 200 R of ^{137}Cs gamma radiation; the fourth received both mitomycin C and radiation. These mice were then mated with females at 4 day intervals over a period of 46 days. Results are tabulated for percent females with implants, implants per female, live embryos per female, dead implants, and embryonic litter size deviation. The combined treatment of mitomycin C and ionizing radiation had a pronounced synergistic effect on sterile matings. Results are discussed with relation to the frequency of induced dominant lethal mutations in spermatocytes. (H.L.W.)

23107 HEPATIC GLUCONEOGENESIS AND GLYCOGENESIS IN THE STARVED, X-IRRADIATED RAT. Sobocinski, P. Z.; Altman, K. I. (Univ. of Rochester, N. Y.). Radiat. Res.; 49: No. 2, 390-404(Feb 1972).

Rats were starved for 24 hours before and 72 hours after 750 R total body x-irradiation. The exposure to x-rays was preceded by intensive labeling of tissue proteins with alanine-UL-^{14}C. Radioactivity and chemical analytical data on hepatic glycogen and free glucose as well as on plasma glucose indicate that ^{14}C-alanyl residues derived from degraded tissue proteins contribute significantly to the pool which serves as a source of carbon atoms for the radiation-induced increase in hepatic gluconeogenesis and glycogenesis. Specific inhibitors of gluconeogenesis provided further evidence for the utilization of ^{14}C-alanyl residues of proteins for gluconeogenesis and glycogenesis via the pathway of reverse glycolysis. The most potent of the three inhibitors used in this study, namely, quinaldate, caused a reduction of the hepatic glycogen content and ^{14}C activity as well as increase in plasma glucose in x- and sham-irradiated rats, whereas L-tryptophan and quinolinate had no effect on hepatic glycogen metabolism or plasma glucose in sham-irradiated rats. The results obtained with inhibitors suggest that glycerol can be excluded as an important source of carbon atoms of gluconeogenesis and glycogenesis in livers of x-irradiated rats. It appears unlikely that a radiation-induced decrease of glycogenolysis plays an important role as a contributing factor in the accumulation of hepatic glycogen during the first 48 hours when glycogen deposition attains maximal values of livers of starved, x-irradiated rats. (auth)

23108 EFFECT OF X-IRRADIATION ON THE INTERACTION OF FLASH-EVOKED CORTICAL POTENTIALS. Daugherty, John H.; Barnes, Charles D. (Indiana Univ., Bloomington). Radiat. Res.; 49: No. 2, 359-66(Feb 1972).

Double light flashes were used to study the effects of x-irradiation on the visual pathway in cats. Evoked cortical responses recorded on the surface of the dura over the visual cortex indicated that changes in the visual response can occur after a 300-R accumulated exposure when double flashes are presented to the eye, even though the response to a single light flash may remain unaltered. (auth)

23109 OVARIAN DEVELOPMENT AND FERTILITY OF THE PROGENY OF MICE IRRADIATED BEFORE MATING. Byskov, Anne Grete; Peters, Hannah (Finsen Inst., Copenhagen). Radiat. Res.; 49: No. 2, 351-8(Feb 1972).

Bagg mice were irradiated with 300 R x-ray (F_0 mice), and mated immediately afterward. The development of the ovaries and the fertility of their female offspring (F_1) were investigated. The ovaries of the F_1 mice showed early signs of aging but the number of oocytes was not altered. The fertility of the F_1 mice was different from the normal. The F_1 mice produced more young than the control animals. The mortality rate was higher in the F_1

mice, many dying with mature embryos in utero, apparently unable to give birth. It is reasoned that the observed changes are probably not due to genetic damage but rather to an altered maternal hormonal milieu initiated by radiation of the F_0 animal. (auth)

23110 MECHANISMS OF ACUTE INJURY IN THE GAMMA-IRRADIATED CHICKEN: EFFECTS OF A PROTRACTED OR A SPLIT-DOSE EXPOSURE ON THE FINE STRUCTURE OF THE MICROVASCULATURE. Stearner, S. P.; Sanderson, M. H. (Argonne National Lab., Ill.). Radiat. Res.; 49: No. 2, 328-50 (Feb 1972).

The effect of radiation dose and time, both during and between exposures, on ultrastructural changes in the microvasculature has been studied in the mesentery of the 3-week-old chicken. The following ^{60}Co gamma-ray exposure groups were compared: 1200 R, Single (15 minute) exposure (>70% mortality within 24 hours). Within three hours after exposure, endothelial as well as interstitial connective tissue cells were severely damaged. Lesions included dilated mitochondria and endoplasmic reticulum (ER) cisternae, cytoplasmic vacuolization, lysis, and necrosis. There were disruptions of the endothelial barrier, and thrombosis and occlusion of small vessels. 700 R, Single (15 minute) exposure (<5% mortality within 24 hours). Patent endothelial junctions and perivascular accumulations of extravasated plasma were present, but little frank cell degeneration was seen. 10,000 R, Single exposure protracted over 24 hours (10% mortality within 24 hours after completion of the exposure). Ultrastructural changes within 24 hours after end of the irradiation were similar to those seen after the 700 R exposure. Split-dose exposure of 700 R, 4-hour interval, 1200 R (<5% mortality within 24 hours). Cellular changes within 4 hours after the end of the second fraction were also no greater than those found after 700 R alone. The variability in endothelial damage after lethal irradiation reveals a range of sensitivities at the cellular level. Direct radiation injury is probably the principal factor in early vascular effects in the chicken. Reversal or repair of radiation effects was previously suggested to result in the decreased dose effectiveness that occurs with a protracted exposure. Absence of extensive ultrastructural changes after the protracted exposure provides additional evidence of intracellular repair processes. Increased cellular metabolism was indicated by the greater pinocytotic activity and the dilated ER cisternae filled with electron-dense material. The radioresistance revealed after the split-dose exposure may result from temporary depletion of some substance activated or released by the first exposure. (auth)

23111 INFLUENCE OF INTESTINAL MUCOSAL RENEWAL RATE ON DEVELOPMENT OF GASTROINTESTINAL INJURY SURVIVAL TIME OF IRRADIATED GERBILS. Nelson, John M. (Univ. of Michigan, Ann Arbor). Radiat. Res.; 49: No. 2, 367-80(Feb 1972).

Because the Mongolian gerbil (Meriones unguiculatus) survives more than twice as long as the mouse after doses of ionizing radiation sufficient to cause GI death, a correlation between survival time and the rate of development of the fatal lesion has been postulated. Autoradiographic methods were used to follow labeled epithelial cells as they migrated from the base of the crypts to the tips of the villi in the terminal ileum and to compare renewal rates for both normal and sublethally irradiated gerbils and mice. This renewal time was found to be in excess of 120 hours for the normal Mongolian gerbil in contrast to about 48 hours for the Swiss mouse. In addition, the migration rate was effectively attenuated by sublethal irradiation in both species. This effect was most striking in the case of the gerbil where extrapolation of renewal time data indicates an increase in renewal time of at least 20% over unirradiated controls; this was more than twice the increase demonstrated by the mouse. The observed difference in survival times is consistent with this difference in epithelial renewal rates, and may be a major factor contributing to the long survival time of supralethally irradiated gerbils, particularly when radiation attenuation of migration is considered. (auth)

23112 EFFECT OF X-IRRADIATION UNDER VARIOUS TEMPERATURE CONDITONS AND EMBRYONIC DEVELOPMENTAL STAGES ON THE GROWTH AND MORTALITY OF CHINOOK SALMON. Wadley, Gerald Weldon. Seattle; Univ. of Washington (1971). 125p. University Microfilms Order No. 71-28,488.

Thesis.

Embryonic stages of chinook salmon which included the one-cell, 32-cell, gastrula, epiboly, blastopore closure, and eyed, were exposed to acute, graded doses of x-radiation. Prior to, during, and following irradiation the embryos were incubated at various temperatures and temperature regimes; i.e., fluctuating or constant, and reared just past active feeding and preserved for examination. Radiosensitivity of the embryos in terms of LD_{50} generally decreased with age but increases in temperature above ambient tended to decrease the LD_{50} of embryos independent of the developmental stage irradiated. Sublethal doses of x-radiation significantly stimulated growth as measured by length and weight. Initiation of growth stimulation by x-radiation did not appear to be temperature dependent but a temperature x dose interaction significantly influenced the mechanism following initiation. This influence resulted, in general, in realization of growth stimulation from a lower dose when administered at an elevated temperature than at a lower temperature. The mechanism responsible for growth stimulation, even though initiated by x-radiation, appeared to be retarded by a constant temperature regime as compared to a temperature regime that followed the normal seasonal fluctuations. Pre-irradiation handling of eggs significantly increased mortality and retarded growth of survivors. The increase appeared to be independent of incubation temperature and could be correlated directly with periods of active differentiation of the embryo. Retardation of growth as a result of handling could also be correlated with active differentiation but, unlike mortality, was temperature dependent. (Diss. Abstr.)

23113 INTESTINAL ABSORPTION OF MAGNESIUM. Tansy, Martin Francis (Temple Univ., Philadelphia). pp 193-210 of Intestinal Absorption of Metal Ions, Trace Elements, and Radionuclides. /Skoryna, S. C. (ed.). Elmsford, N. Y.; Pergamon Publishing Co. (1971).

A review of the literature on intestinal magnesium absorption is presented together with a discussion of the relation of magnesium to the acute intestinal radiation syndrome. Among the changes in chemistry that accompanied the anatomical and functional changes seen in rats exposed to whole-body gamma radiation (^{60}Co) were those in serum and intestinal magnesium levels. Intestinal magnesium levels were biphasic: an early post-radiation increase followed by a decrease below non-radiated controls. A transient decrease in serum magnesium was found concurrently with the early intestinal magnesium increase. The degree of hypomagnesemia after whole-body radiation often determined the animals' survival or exitus. Feeding of large supplements of magnesium silicate, intraperitoneal magnesium chloride, or intramuscular parathyroid extract affords almost complete protection against damage from gamma radiation. Protection is associated with reduction in the extent of the pathological changes noted above. The mechanism of action is discussed. Attention is also directed to the possible role of magnesium as a biological dosimeter in radiation. (auth)

23114 TISSUE EFFECTS OF RADIATION IN RELATION TO RADIO THERAPY. Lindop, Patricia J. (St. Bartholomew's Hospital, London). Curr. Top. Radiat. Res.; 6: 293-324(1970).

The subject is reviewed under the following topics: radiation response of the mouse skin; radiation effects on blood vessels; radiation effects on tumor tissue; and comparison of normal and tumor tissue responses. The role of dose fractionation and tumor hypoxia are also considered. (33 references). (E.R.B.)

23115 TEMPORARY RETARDATION OF CARTILAGE GROWTH IN MICE AFTER EXTERNAL β-IRRADIATION. Simmons, D. J.; Hakim, R.; Cummins, H. (Argonne National Lab., Ill.). Experientia; 27: No. 10, 1210-11(15 Oct 1971).

A ^{90}Sr-^{90}Y source in the form of ceramic microspherules embedded in polyurethane sheets was used. Irradiation was performed by inserting mice in tubes with head shielded. Total body surface doses were 5000 and 7200 rads for 11 and 16 hr. The hind limbs recovered at autopsy were stained and sectioned and the thickness of the proximal tibial growth cartilage was measured. It was found that the cartilages became 25% thicker but thinned progressively from day 3 to 7 and recovery occurred from day 9 to 13. It is suggested that the changes in the cartilage were due mainly to an effect of irradiation on cell division and matrix synthesis. (H.L.W.)

23116 DOSE-RESPONSE RELATIONSHIPS FOR YIELDS OF MAJOR EYE MALFORMATIONS FOLLOWING LOW DOSES OF RADIATION TO TROUT SPERM. McGregor, John F.; Newcombe, Howard B. (Chalk River Nuclear Labs., Ont.). Radiat. Res.; 49: No. 1, 155-69(Jan 1972).

Low doses of ionizing radiation in the range 25 to 400 rad to mature trout sperm have resulted in major eye malformations in the immediate offspring, with frequencies which fit a linear regression curve. A weighted mean of the responses per unit dose indicates that approximately 54 rad would be required to double the rate of malformations observed in the controls. It is believed that the major eye malformations observed in the present work are due predominantly to chromosome aberrations induced in the mature sperm. The reasons for the interpretation and the relevance of the observed linearity to the problem of protecting man against radiation-induced genetic injury are discussed. (auth)

23117 EFFECT OF IONIZING RADIATION ON THE ENZYMES OF THE INTESTINAL MUCOSA OF RATS AT DIFFERENT TIME INTERVALS AFTER ABDOMINAL IRRADIATION. Becciolini, A.; Ravina, A.; Arganini, L.; Castagnoli, P.; De Giuli, G. (Univ., Florence). Radiat. Res.; 49: No. 1, 213-25 (Jan 1972).

The enzyme content of the brush border of the small intestine was measured after exposure of the abdomen of rats to 500 and 800 R, respectively, of gamma radiation from a cobalt-60 source. Enzyme activities determined between 4 hours and 16 days after exposure indicated that there were modifications in lactase, maltase, invertase, alkaline phosphatase, LAP (leucineaminopeptidase), and total protein content in homogenates of different segments of the small intestine. The first demonstrable effect, occurring between 4 and 36 hours after exposure was an increase in enzyme activity, which was more marked after 500 R than after 800 R. Thereafter the depression in enzyme levels was correlated with the degree of abnormality of the epithelium. Recovery was almost complete at 5 days after 500 R. Although the activity of some of the enzymes had partly recovered at that time after 800 R, full recovery to preexposure values had still not occurred at 11 days after exposure. Histologic damage to the epithelium, particularly in the villi, was more serious during the time of the greatest functional impairment. (auth)

23118 EFFECTS OF WHOLE-BODY X-IRRADIATION UPON THE DEGRADATION OF ^{14}C-LABELED PLASMA PROTEINS IN INTACT AND EVISCERATED RATS. Irwin, J. Foster; Miller, Leon L. (Univ. of Rochester, N. Y.). Radiat. Res.; 49: No. 1, 226-32(Jan 1972). (UR-49-1445).

Plasma proteins labeled with L-leucine-1-^{14}C have been given intravenously to adult male rats to study the effects of whole-body x-irradiation and the role of the gastrointestinal tract on catabolism of plasma proteins to $^{14}CO_2$. Comparison of normal and irradiated eviscerated surviving rats reveals that substantial catabolism of L-leucine-1-^{14}C-labeled plasma proteins to $^{14}CO_2$ occurs in the absence of the liver, spleen, gastrointestinal tract, and pancreas. The overall effect of whole-body x-irradiation was to enhance the apparent extent of oxidation of ^{14}C-labeled plasma proteins. Included for comparison are observations on the oxidation of a tracer dose or of a loading dose of L-leucine-1-^{14}C in normal and irradiated eviscerated surviving rats. (auth)

23119 EXPERIMENTAL RADIOTHERAPY WITH FAST NEUTRONS: INFLUENCE OF INTRACELLULAR RECOVERY AND OF TISSUE REOXYGENATION. Magno, L. (Spedali Civili, Brescia, Italy). Radiaz. Alta Energ.; 10: No. 3, 131-42(Jul 1971). (In Italian).

Radiobiological experiments on the survival of cells of neoplastic and normal tissues in rats following exposure to fast neutrons have provided evidence of some correlations existing between degree of RBE, type of irradiated substratum, and amount of administered dose. In the case of neutrons, RBE varies between two or three times that of γ and x radiation and electrons. Variations are great enough to make the use of neutrons in radiotherapy, at least for the time being, quite difficult. But more important than RBE levels in themselves is the comparison between different RBEs of neutrons for different tissues and, above all, the evaluation of the ratio between neutron RBE for healthy tissues and for neoplastic ones. In fact, the main reason for practical use of neutrons is that their damaging effect on hypoxic cells is greater than in the case of photons or electrons. The results of recent experiments confirm the existence of a theoretical therapeutic advantage in using neutrons for irradiating experimental tumors. (auth)

23120 MAJOR ORGAN DOSIMETRY OF THE RAT EXPOSED TO FOUR X-RAY ENERGIES. Maillie, H. D.; Krecidlo, L.; Mermagen, H. (Univ. of Rochester, N. Y.). Health Phys.; 22: No. 1, 79-85(Jan 1972).

Small thermoluminescent dosimeters were implanted in rat carcasses which were representative of live animals to be used in radiobiological studies. These carcasses were exposed to wholebody irradiations of 80, 150, 250 and 1000 kVp x-rays. The dosimeters were implanted in representative soft-tissue organ sites and in those bones which were of sufficient size to permit the insertion of the dosimeters. Under the conditions of exposure used here, the average soft-tissue doses were 0.739, 0.888, 0.860 and 0.846 rad/Roentgens Midline Air Exposure (RMAE) in the order of increasing energy leading to the conclusion that there was little difference among them for the three higher energies. Similar averages for the marrow of the long bones showed averages of 0.680, 0.845, 0.749 and 0.796 rad/RMAE and for the marrow of the spinal segments, 0.612, 0.931, 0.834 and 0.773 rad/RMAE with increasing incident photon energies. (UK)

23121 FURTHER EVALUATION OF N,N'-POLYMETHYLENE-BRIDGED 2-AMINOETHANETHIOL DERIVATIVES AND RELATED COMPOUNDS AS RADIOPROTECTIVE AGENTS. Piper, James R.; Stringfellow, Carl R. Jr.; Johnston, Thomas O. (Kettering-Meyer Lab., Birmingham, Ala.). J. Med. Chem.; 14: No. 12, 1212-17(Dec 1971).

The radioprotective effectiveness of N,N'-polymethylene-bridged 2-aminoethanethiol derivatives was determined in mice. The derivatives were administered to the mice by intraperitoneal injection prior to γ irradiation. (E.R.B.)

23122 ROENTGEN STUDIES OF THE BONE GROWTH IN RATS BY MEANS OF MEASUREMENTS OF TIBIAL LENGTH. Somora, J.; Pelech, L. (Univ., Duesseldorf). Z. Versuchstierk.; 12: 77-83(1970). (In German).

It was demonstrated that radiation burden formed in repeated x ray, does not affect body weight and length of tibia. Dispersion of measurement data on body weight is greater than dispersion data on length of tibia. Data on length of tibia are therefore especially suitable. (auth)

23123 PERIVENTRICULAR GOMORI-POSITIVE GLIA IN BRAINS OF X-IRRADIATED RATS. Srebro, Zbigniew (Inst. of Biomorphology, Krakow). Brain Res.; 35: No. 2, 463-8(Dec 1971).

Chrome hematoxylin-positive granule-containing periventricular glial cells were counted in the nucleus arcuatus of normal and locally x-irradiated rats. A statistically significant increase in number of these cells was found in the irradiated animals on the seventh day post-exposure. This increase was observed only after 3000 R and 4000 R, lower doses producing no significant alteration. Cells in the irradiated animals showed more granulations than did similar cells in controls. The "Gomori-positive" granulations of the periventricular glia are large cytoplasmic organelles most closely related to peroxisomes. Their supposed role is detoxication by decomposition of organic peroxides. (auth)

23124 HEMOGLOBIN ALTERATIONS IN THE GAMMA-IRRADIATED SPANISH GOAT. Travis, James C. (Univ. of Texas, Austin); Brown, Sidney O. Comp. Biochem. Physiol.; 41B: No. 1, 165-9(15 Jan 1972).

Blood samples from control and γ-irradiated Spanish goats were characterized for hemoglobin. Cellulose acetate electrophoresis demonstrated the presence of a hemoglobin, designated C, in 52% of the irradiated animals that was not observed in any of the controls. This hemoglobin was electrophoretically distinguishable from goat fetal hemoglobin. An inverse relationship was observed between total hemoglobin and hemoglobin C, indicating that the appearance of hemoglobin C is an indirect response to irradiation via an induced anemia. (auth)

23125 RECOVERY FROM LETHAL X-RAY DAMAGE DURING DELAYED IMPLANTATION IN THE RAT. Ward, W. F.; Meyer, R. K.; Wolf, R. C. (Univ. of Wisconsin, Madison). J. Endocrinol.; 51: No. 4, 657-63(Dec 1971).

Rats were exposed to either 300 or 500 R acute whole-body x irradiation on the 5th day of delayed pregnancy induced by ovariectomy. From 0 to 8 days after irradiation, implantation was induced by the administration of oestrogen. Foetal survival to the 20th day of development was used as an index of radiation effect. If oestrogen was given immediately after exposure to 300 R, or 12 h later, only 30 to 35% of the embryos survived, significantly less ($P < 0.01$) than the non-irradiated control values of 74 to 79%. When implantation was postponed for 24 h or more, embryonic survival ranged from 57 to 64% and was not significantly different from that of controls. After exposure to 500 R x irradiation, embryonic survival increased linearly from 2% to a maximum of 41% as the interval between irradiation and oestrogen administration increased from 0 to 48 h. Embryonic survival never reached control levels after 500 R, regardless of the interval between irradiation and implantation. The irradiation regimens also induced developmental abnormalities, doubled the incidence of dead foetuses (death at a late stage of development), and significantly reduced foetal and placental weights at autopsy. The results confirm that recovery from potentially lethal x irradiation damage can occur during delayed implantation, and demonstrate that both the extent and the rate of recovery are functions of the radiation dose. (auth)

23126 EXPERIMENTAL STUDY OF THE EFFECT OF CHEMICAL PROTECTIVE AGENT ON THE POSTIRRADIATION BLADDER DAMAGE. Ito, Yoshiko (Tokyo Women's Medical Coll.). Nippon Igaku Hoshasen Gakkai Zasshi; 31: No. 2, 143-51(May 1971). (In Japanese).

Animal experiments were performed to evaluate the effect of radiation protection by the administration of chemical protective agent, 5-hydroxytryptophan (5-HTP) in the case of bladder damage following the radiotherapy of carcinoma of the cervix uteri. Female mice were used as an experimental animal. The shield was made to cover the entire body by 4 mm thickness lead which had a round hole of 1.5 cm diameter. The bladder irradiation was made through this hole. The occult blood in urine was present following the irradiation to the bladder. The amount of the blood present in the urine was dependent upon the irradiation dose. The mice were divided into two groups: the protected group that received intraperitoneal administration of 5-HTP and the control group. There was no difference in the urine between the two groups after irradiation of 1000 rads to the bladder. However, at 2000 rads, the amount of the blood in the urine was markedly decreased in the protected group. It is concluded from the experiment that the bladder damage is less following the intraperitoneal administration of 5-HTP. This is also true with intravesical administration of 5-HTP. (auth)

23127 DOSE DELIVERED TO THE BONE MARROW OF THE RAT IRRADIATED TO X RAYS OF FOUR ENERGIES. Maillie, H. D ; Krecidlo, L.; Mermagen, H. (Univ. of Rochester, N. Y.). Health Phys.; 22: No. 4, 394-5(Apr 1972).

A combination of ^{58}Fe liver uptake measurements and LiF and CaF_2 dosimeter implants in the humeri, femurs, and spinal canal was used to estimate the dose delivered to rat hematopoietic centers for whole-body x irradiation of the following incident energies: 80, 150, 250, and 1000 kVp. There appeared to be a relationship between bone marrow rad/Roentgen factors and effective photon energy and the long bones did not appear as greatly affected by the lower energies as the other sites. (UK)

23128 AUTORADIOGRAPHIC INVESTIGATIONS ON THE EFFECT OF SEVERAL RADIOPROTECTORS ON DNA-SYNTHESIS IN THE EMBRYONIC BRAIN OF THE RAT. Wegner, G.; Schmahl, F.; Windt, H. (Univ., Freiburg i B.). Verh. Deut. Ges. Pathol.; 54: 475-80(1970). (In German).

The interaction and protective effect of several radioprotectors was investigated autoradiographically by determination of the ^{3}H-(labeling) and the mitotic-index as well as the percentage of pycnotic cells in the embryonic brain analage of rats: Serotonin induced severe shock in pregnant animals and finally led to abortion when x-ray protective doses were administered. ^{3}H-thymidine was not incorporated. AET (S-2 aminoethylisothiourea) more than cysteine caused a decrease of the number of DNA-synthesizing cells and mitosis for as long as 8 hrs after injection, the minimum (about 45%) of the values observed in the control animals being at 1 hr p. inj. When administered before whole-body irradiation a further decrease of the ^{3}H- and mitotic index as it was observed after sole x-ray treatment, was stopped. Furthermore the protective effect became evident in a smaller number of pycnotic cells. (auth)

23129 RADIATION EFFECT ON THE LIVER INDICATED BY THE REGENERATIVE CAPACITY. Ishikawa, Nobuyuki (Showa Univ., Tokyo). Showa Igakkai Zasshi; 30: No. 12, 788-94(Dec 1970). (In Japanese).

Experiments were conducted to determine radiation injury on resting cells. Regenerating liver adequately provided the material in this experiment. Irradiation was administered to the liver prior to partial hepatectomy. Radiation effects were estimated by DNA synthetic rate and mitosis in the regenerating liver. From the measurement of deoxyuridine riboside-^{125}I uptake and from the studies of autoradiograms, it was indicated that DNA synthetic rate was decreased and onset of the synthesis was delayed, the extent of which was dependent on the time interval between irradiation and hepatectomy; 24 hours or more time interval revealed recovery from these injuries. However, it was suggested in the histological studies that these injuries were at least partially the results of permanent cell damage to be proliferated. These discrepancies remained to be explored. (auth)

23130 ADVANCES IN RADIATION BIOLOGY. VOLUME 3. Augenstein, Leroy G.; Mason, Ronald; Zelle, Max (eds.). New York; Academic Press, Inc. (1969). 346p. $17.50.

Separate abstracts were prepared for four chapters of the book. Additional chapters are included on low energy electron mean free paths in solids and the molecular biology of photodynamic action. (H.L.W.)

For abstracts of individual chapters see: 23034, 23084–23085, and 23172.

23131 ACUTE CHANGES IN THE CENTRAL NERVOUS SYSTEM OF MONKEYS EXPOSED TO PROTONS. Haymaker, Webb; Ibrahim, M. Z. M.; Miquel, Jaime; (and others). J. Neuropathol. Exp. Neurol.; 31: No. 1, 72-101(Jan 1972).

Studies were made on changes occurring in the central nervous system of 211 monkeys in the first two weeks following exposure of the monkeys to protons of varied energy (32 MeV to 2.3 BeV) given in wide dose and dose-rate ranges (from 6500 rad 32-MeV protons given at 1000 rad/min to 350 rad 2.3 BeV protons given at 22 rad/min). Depth beneath the brain surface reached by the 32-MeV protons was 10 mm, and for 55-MeV protons 26 mm; protons of higher energies (138 MeV, 400 MeV and 2.3 BeV) completely penetrated the brain. Ionization density per unit of brain tissue appeared greatest for the 32-MeV protons. Since an inflammatory reaction and glycogen accumulation in astrocytes occurred in practically all the animals, the threshold dose (and dose rate) for the elicitation of these responses was not ascertainable. Cerebral cortical necrosis, granule cell pyknosis, and inflammatory reaction occurred at doses far lower than effective for high-energy gamma radiation given other series of monkeys at comparable dose rate. Although the morphological evidence thus indicated that the relative biological effectiveness of the protons was greater than 1, a definite statement on this point cannot be made because the depth dose in the central nervous system was calculated, not measured directly. Metallic impregnation carried out in virtually all the animals revealed a wide variation in glial response even at equal dose and dose rate in the same proton energy series. This was particularly evident in the animals receiving the smaller doses. There was no way of deciding whether these differences were due to insufficient CNS sampling or to individual differences in susceptibility of the animals. Proton energy effect, dose effect, dose-time effect and dose-rate effect were evident in the various morphological categories investigated, but inconsistencies were encountered. (auth)

23132 CELL-TO-CELL INTERACTION IN THE IMMUNE RESPONSE. VII. RADIOSENSITIVITY OF THYMUS-DERIVED LYMPHOCYTES. Anderson, R. E.; Sprent, J.; Miller, J. F. A. P. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). J. Exp. Med.; 135: No. 3, 711-17(1 Mar 1972).

When thymus-derived lymphocytes were injected into heavily irradiated hybrid mice, they proliferated in the lymphoid tissues as a result of activation by foreign histocompatibility antigens. Incorporation of tritium-labeled thymidine into irradiated lymphocytes was markedly reduced when the dose was 300 rads and was abolished at 1000 rads. The helper function of carrier-primed thymus cells was found to be radiosensitive in vivo. The results could not be attributed to interference with the spleen-seeking properties of the irradiated cells. It is suggested that thymus cell division is essential for the induction of 7S antibody responses in vivo. (H.L.W.)

23133 RESTORATIVE EFFECT OF PERITONEAL MACROPHAGES ON DELAYED HYPERSENSITIVITY FOLLOWING IONIZING RADIATION. Volkman, Alvin; Collins, Frank M. (Trudeau Inst., Saranac Lake, N. Y.). Cell. Immunol.; 2: No. 6, 552-66 (Dec 1971).

Sublethal whole-body irradiation in the guinea pig had little demonstrable effect on the development of delayed hypersensitivity but caused a profound, though transient depression of dermal reactivity in previously sensitized animals. Macrophage-rich peritoneal cell suspensions from non-sensitive donors, when injected intradermally with eliciting antigen, resulted in the restoration of a significant degree of reactivity following irradiation. Inocula of lymphocytes, on the other hand, failed to yield similar results. These findings, when taken with the persistence of low levels of reactivity following irradiation and the ability to transfer reactivity with peritoneal exudate cells from animals so treated, warrant the conclusion that the presence of macrophages is necessary for the expression of cutaneous delayed hypersensitivity. The spontaneously renewed activity which follows the depressed phase is thus more of a reflection of the recovery of macrophage precursors from radiation injury, rather than the emergence of a new population of sensitized cells. The results, in addition, substantiate the belief that the expression of delayed hypersensitivity requires at least two cell populations, only one of which carries the property of specificity at the outset. The presence of the sensitized population cannot always be excluded by a weak or absent skin test. (auth)

23134 EXPRESSION OF EMBRYONIC AND ADULT ERYTHROCYTE ANTIGENS IN HEMATOPOIETIC REPOPULATED X-IRRADIATED CHICKENS. Sanders, Bob G.; Wiley, K. L. (Univ. of Texas, Austin). J. Exp. Zool.; 178: No. 3, 393-8(Nov 1971).

An antigen is present on the red blood cells of embryonic and young chickens which is lost during development and is undetect-

able on the red blood cells of adult chickens. Two experiments were performed to determine the presence or absence of the embryonic antigen. First, spleen, liver and bone marrow cells obtained from three day old chicks were transplanted into x-irradiated adult chickens in order to determine if the embryonic antigen would be expressed on red blood cells in an adult environment but arising from transplanted "young" cells. Red blood cells from the adult x-irradiated chickens were assayed at various intervals after transplantation for the presence of the embryonic antigen. Additional red blood cell antigenic markers other than the embryonic antigen demonstrated repopulation in the x-irradiated chickens, but the embryonic antigen was not detectable. Second, three day old, non-irradiated chickens were transplanted with adult chicken bone marrow cells and their red blood cells assayed at varying intervals up to 40 days in order to determine the effect of a "young" environment upon adult cells. These chickens continued to express the embryonic antigen on all their red blood cells; i.e., no adult-like cells were found up to 40 days. The x-irradiation-transplantation studies indicate that the erythropoietic stem cells containing gene(s) coding for the embryonic antigen are repressed in the adult chicken and that in the young chicken repopulated with adult hemopoietic cells the gene(s) are derepressed. (auth)

Invertebrates

23135 (BNWL-SA-4190) POPULATION PERFORMANCE AND CHRONIC GAMMA RADIATION. Erdman, Howard E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1972]. Contract AT(45-1)-1830. 16p. (CONF-720203-1). Dep. NTIS.

From Joint meeting of the Southwestern Branch of the Entomological Society of America and Sociedad Mexicana de Entomologia; Mexico City, Mex. (13 Feb 1972).

Modifications of population performance measured as reproductive capacities are of concern in radiation ecological studies because such changes are usually detrimental to the species and will be selected against by natural selection. Data are reported on the performance of flour beetle (Tribolium confusum and T. castaneum) populations during 18 months of chronic γ (^{60}Co) irradiation. For both species, 5 replicate populations, begun with 20 pairs of virgin beetles, received 24, 49, or 170 R/day. Populations were established at 25° and 32°C at 70 to 75% RH on 5 g of standard food 8 months before radiation. At monthly censuses numbers of larvae, pupae, and adults were determined. Tribolium castaneum was reproductively more fit than T. confusum at 25° and 32°C with no radiation and at 25°C with 49 R/day; T. confusum was more fit at 32°C and 49 R/day and at 170 R/day in both temperatures. The dose rates used are not feasible for insect control. At 25°C the reproductive performances were reduced yet comparable at 24° and 49 R/day. At 170 R/day extinction was observed. Larvae were more radiation sensitive than adults. When larvae were present, numbers of adults failed to increase, indicating that larvae failed to metamorphose. Parameters of radiosensitivity were accentuated at 32°C. Radiation effects are explained radiobiologically: developing immature stages characterized by growth and cell divisions were more radiosensitive than adult stages characterized by no growth and few cell divisions (except for meiosis). Responses to radiation were determined by interactions among temperature, dose rate, and species. Radiation ecology should consider the physical-chemical-biological interrelationships for several generations in order to assess and predict the consequences of radiation in the biosphere. (auth)

23136 (ORO-2575-51) ACTION OF ACTINOMYCIN D ON MITOTIC ACTIVITY AND ON X-RAY-INDUCED PROPHASE REVERSION IN NEUROBLASTS OF CHORTOPHAGA VIRIDIFASCIATA (DeGEER). Stephens, Ralph Edmund (Tennessee Univ., Knoxville). Aug 1970. 57p. Dep. NTIS.

Thesis.

Stained squash preparations of grasshopper neuroblasts in hanging drop cultures were used for studies on the effects of RNA synthesis on the recovery process of x-ray-induced prophase reversion. Results led to the conclusions that: yolk is necessary to maintain a high mitotic rate in hanging drop cultures; RNA synthesis is necessary for recovery from x-ray-induced prophase reversion; and the normal function of nucleoli is inhibited by actinomycin D in telophase of nonirradiated cells and in prophase of cells exposed to 64 R x radiation. (H.L.W.)

23137 IMMUNIZATION OF CHICKEN AGAINST ASCARIDIA GALLI. Deo, P. G.; Tripathi, J. C. (IVRI, Izatnagar, India). Indian J. Vet. Sci. Anim. Husb.; 38: No. 4, 753-5(1968).

Single oral vaccination of chickens with 500 infective eggs irradiated at 5,000 and 10,000 R of γ-rays induced a strong resistance in them against the challenge infection of 1,000 non-irradiated infective eggs of Ascaridia galli. (auth) (Indian Sci. Abstr.)

23138 EFFECT OF X RAYS ON THE REGENERATION OF THE ORAL STRUCTURES OF HYDRA VULGARIS. II. ROLE OF INTERSTITIAL CELLS IN THE PROCESS OF REGENERATION. Bhattacherya, Satyabrata (Presidency Coll., Calcutta). Z. Biol.; 116: No. 6, 487-93(Apr 1971).

Two lethal doses of x rays, 25,000 and 40,000 rads, were employed on Hydra vulgaris and the radiated animals were amputated at the subhypostome, on different days. The regeneration of the tentacles and hypostome was studied at the cellular level, for 120 hours after excision. Within 96 hours of radiation most of the interstitial cells were depleted from the regenerating column but a sizable percentage could regenerate tentacles. Under these circumstances the hydras which regenerated tentacles were devoid of nematocysts and were mostly composed of ectodermal epithelial cells. A transient recovery phase was observed in the 12th day series with both the doses. Though the radiated hydras formed tentacles and the so-called hypostome in the absence of interstitial cells, the perfect histological specificity of the lost structures could never be brought back without the contribution of the interstitial cells. The wound healing and reconstitution of the structures were carried out by the orientation of the existing cells of the body. (auth)

23139 EFFECT OF X RAYS ON THE REGENERATION OF THE ORAL STRUCTURES OF HYDRA VULGARIS. I. EFFECT OF X RAYS ON THE RATE OF REGENERATION. Bhattacherya, Satyabrata (Presidency Coll., Calcutta). Z. Biol.; 116: No. 6, 480-6(Apr 1971).

Regeneration of the hypostome in Hydra vulgaris under the influence of x rays was studied. Two lethal doses of 25,000 and 40,000 rads were used. Hydras were amputated on different days after radiation. The regenerates were observed till their degeneration. Both the doses showed a similar trend in the rate of regeneration. In the 12th day series, the radiated hydras showed a transient recovery effect. On the 18th day, none of the hydras in 40,000 rads could regenerate tentacles and only 6 out of 20 hydras regenerated tentacles in 25,000 rads. The hydras which could not regenerate either remained blocked or disintegrated. During the post regenerative phase, the nematocysts were gradually depleted and the hydras appeared smooth and flaccid. The post regenerative survival period varied with the dose of radiation and the time passed after radiation prior to amputation. (auth)

23140 EFFECT OF X RAYS ON THE REGENERATION OF THE ORAL STRUCTURES OF HYDRA VULGARIS. III. CONTRIBUTION OF ENDODERM CELLS IN WOUND HEALING AND HYPOSTOME DIFFERENTIATION. Bhattacherya, Satyabrata (Presidency Coll., Calcutta). Z. Biol.; 116: No. 6, 493-501 (Apr 1971).

Regeneration of Hydra vulgaris under the influence of x rays was studied. Two lethal doses of 25,000 and 40,000 rads have been used. Hydras were amputated on different days after radiation and were allowed to regenerate. The physical and metabolic stability of the cells is profoundly affected by the radiation action causing delay in wound healing. A gradual inhibition of migration and secretion of the gland cells is directly responsible for the delay in wound healing. The gland cells are found to be highly sensitive to radiation action. The profuse secretion of the gland cells during the second phase of regeneration leads to the formation of abnormal hypostome. During delamination, the differentiation of endoderm cells to ectoderm is significantly affected. The process of dedifferentiation and further redifferentiation of endoderm cells is either inhibited or takes an abnormal course. Excessive amount of cell loss results in the blocked condition of the regenerates. Blocked regenerates develop fibrous and thicker ectoderm at the distal end. The endodermal cells are highly vacuolated in the blocked regenerates. (auth)

23141 CHRONIC TISSUE DEGENERATION IN THE PACIFIC OYSTER: CRASSOSTREA GIGAS, FOLLOWING ACUTE γ-IRRADIATION. Mix, Michael C. (Oregon State Univ., Corvallis). Radiat. Res.; 49: No. 1, 176-89(Jan 1972).

The purpose of this study was to determine the chronic histopathological effects of irradiation on three tissues of the oyster—gut, digestive tubules, and gills—and attempt to correlate degenerative syndromes with effects on cell renewal systems. Tissues in oysters irradiated with 1, 5, 10, 20, 50, 75, and 100 krads showed degeneration which could be classified as acute or chronic depending on the relation to mitotic inhibition. All three tissues underwent chronic degeneration which was directly related to mitotic inhibition. Complete and long-lasting mitotic inhibition

occurred in the gut of all experimental oysters except those irradiated with 1 or 5 krads. The number of mitoses was reduced in these oysters, but complete inhibition did not occur. Chronic degeneration in the gut was manifested by a gradual loss of cells and a subsequent decrease in the size of this organ. Chronic degeneration of the gills resulted in atrophy, cellular hypertrophy and replacement of normal connective tissue by collagen. Complete denudation was the ultimate observable manifestation in the digestive tubules. All normal epithelial cells associated with this structure disappeared and only an abnormal squamous cell lining remained. (auth)

23142 GAMMA-RADIATION EFFECTS ON TROGODERMA INCLUSUM AND T. VARIABILE. Brower, John H.; Tilton, Elvin W. (Dept. of Agriculture, Savannah). J. Econ. Entomol.; 65: No. 1, 250-4(Feb 1972).

Effects of gamma radiation exposures of 5–100 krad on all developmental stages of Trogoderma inclusum Le Conte and T. variabile Ballion were studied. Results with the 2 species were similar. Development of adults from treated eggs and larvae was prevented by 5 krad. Some adults emerged from pupae at all treatment levels, but no reproduction occurred at 30 krad or above. Adult females were more sensitive to the sterilizing effects of gamma radiation than were males. All adults were sterilized when irradiated at 30 krad or above. Control of the 2 species appears feasible with levels of radiation currently approved for treatment of stored-grain insects. (auth)

23143 INTERACTION OF GAMMA RADIATION AND FUMIGATION ON CONFUSED FLOUR BEETLES. Cogburn, Robert R.; Gillenwater, Hagen B. (Dept. of Agriculture, Savannah). Contract AT(49-11)-2676. J. Econ. Entomol.; 65: No. 1, 245-8 (Feb 1972).

Adult Tribolium confusum Jacquelin duVal were treated with various combinations of gamma radiation and fumigants (methyl bromide or phosphine). Very low radiation dosages (2–6 krad) usually reduced the effectiveness of methyl bromide fumigation when the radiation treatments were applied first and the fumigations were accomplished within 24 hr. Higher radiation dosages (10–50 krad) followed 7 days later by methyl bromide fumigations generally killed more insects than did either treatment applied alone. A 7-day delay between the irradiation and fumigation provided a definite increase in insect mortality, but reversing the sequence of the treatments did not. The phosphine dosage tested was too high to fully assess the interaction of the radiation-fumigation treatments. However, irradiating the insects did not alter the effectiveness of phosphine when the fumigant alone produced mortalities in excess of 90%. (auth)

23144 INSECT DISINFESTATION OF SHELLED PECANS, ALMONDS, AND WALNUTS BY GAMMA RADIATION. Brower, John H.; Tilton, Elvin W. (Dept. of Agriculture, Savannah). Contract AT(49-11)-2676. J. Econ. Entomol.; 65: No. 1, 222-4(Feb 1972).

Shelled pecans, almonds, and English walnuts were infested with the Indian meal moth, Plodia interpunctella (Hübner), the red flour beetle, Tribolium castaneum (Herbst); or the sawtoothed grain beetle, Oryzaephilus surinamensis (L.), and then treated with 10, 20, or 40 krad of gamma radiation. Reproduction by the beetles was greatly reduced or eliminated by the 10-krad treatment, and at higher levels no offspring were produced. All P. interpunctella were not eliminated by the 10-krad dosage, and 1 survived the 20-krad treatment. Control was complete with 40 krad. A practical level of insect control in bulk nutmeats could probably be achieved by a 20- to 25-krad treatment, but in packaged nutmeats 40 krad would probably be needed to prevent all signs of feeding damage. (auth)

23145 GAMMA RADIATION EFFECTS ON SITOPHILUS ZEAMAIS AND S. GRANARIUS. Brown, Gary A.; Brower, John H.; Tilton, Elvin W. (Dept. of Agriculture, Savannah). J. Econ. Entomol.; 65: No. 1, 203-5(Feb 1972).

The effects of gamma radiation on the maize weevil, Sitophilus zeamais Motschulsky, and the granary weevil, S. granarius (L.) were studied. All stages of these weevils were treated with 5, 10, 20, 30, 50, and 100 krad of gamma radiation from a ^{60}CO source. Eggs and larvae of both species were unable to develop to the adult stage at any treatment level. The emergence of adults from irradiated pupae occurred with doses as high as 50 krad for S. zeamais and as high as 20 krad for S. granarius. A dose of 5 krad in the pupal stage of both species, however, was sufficient to cause sterility. The reproductive ability of irradiated adults was considerably reduced with 5 krad, and complete sterility occurred with 10 krad and above. Survival time of irradiated adults decreased with increasing dose. (auth)

23146 TOXICITY OF MALATHION TO GAMMA-IRRADIATED AND NONIRRADIATED ADULT RED FLOUR BEETLES. Cogburn, Robert R.; Speirs, Roy D. (Dept. of Agriculture, Savannah). Contract AT(49-11)-2676. J. Econ. Entomol.; 65: No. 1, 185-8(Feb 1972).

Tests were conducted to determine the effect of combining treatments of malathion and gamma radiation applied to adult Tribolium castaneum (Herbst). Radiation was applied before the chemical treatment. The dosage of 5 krad did not produce any mortality when applied alone and actually afforded some protection to the insects against the malathion. At dosages of 10 krad or more, however, radiation combined with malathion at the rate 0.05 μg/insect was slightly more lethal than either malathion or radiation alone. Combination treatments produced earlier mortalities than did radiation alone. (auth)

23147 EFFECTS OF TREATING ADULT CODLING MOTH WITH STERILIZING AND SUBSTERILIZING DOSES OF GAMMA IRRADIATION IN A LOW-TEMPERATURE ENVIRONMENT. White, L. D.; Hutt, R. B. (Dept. of Agriculture, Yakima, Wash.). J. Econ. Entomol.; 65: No. 1, 140-3(Feb 1972).

Unfed adult Laspeyresia pomonella (L.) treated in a 3.0 ± 2°C environment with 15 and higher krad of gamma irradiation lived 1–7 days longer than untreated moths. Eggs per female declined as the dose to either sex increased, and the reduction was greater when females only were treated or when treated females were paired with treated males. Males irradiated with 30 krad and paired with untreated females showed over 99.0% sterility. Three apparently normal F_1 male adults resulted from 120 pairing between untreated females and males treated with 30 krad. An inverse relationship existed between the longevity of untreated females and eggs per female, and the increases in longevity of treated females proved to be a function of both dose of irradiation and oviposition. (auth)

23148 STERILIZATION OF THE MEDITERRANEAN FRUIT FLY WITH GAMMA RADIATION: EFFECT ON MALE COMPETITIVENESS AND CHANGE IN FERTILITY OF FEMALES ALTERNATELY MATED WITH IRRADIATED AND UNTREATED MALES. Hooper, G. H. S. (International Atomic Energy Agency, Vienna). J. Econ. Entomol.; 65: No. 1, 1-6(Feb 1972).

Competitiveness of males of Ceratitis capitata (Wiedemann), irradiated in the late pupal stage with 5- to 11-krad gamma radiation was evaluated from the egg hatch resulting when irradiated males were confined in various ratios with untreated pairs of insects. Competitiveness decreased with increased dose. This factor counteracted the increased degree of sterility induced by increased dose, so doses of 5–11 krad led to similar reductions in egg hatch. With increased replication it was possible to distinguish between the degree of control given by 5-, 7-, or 9-krad-treated males and 9 krad gave the poorest control. Although 7 krad allowed a slightly higher level of fertility in males than did 9 krad (5% vs. 1–2%, respectively) the data indicate that use of 7 krad rather than 9 krad should be seriously considered in eradication, and especially suppression, programs for this species. Evidence was obtained that the presence of sterile females neither augmented nor detracted from the degree of control given by irradiated males. The egg hatch of females confined with irradiated males after an initial mating with untreated males was lowered, but to a smaller extent, as the dose given to males was increased from 5 to 11 krad. With the reverse mating sequence the increase in egg hatch was greater as the irradiation dose was increased. (auth)

23149 LINEAR DOSE EFFECT RESPONSE FOR MUTATIONS IN MATURE OOCYTES OF THE WASP [DAHLBOMINUS]. Baldwin, W. F. (Chalk River Nuclear Labs., Ont.). Radiat. Res.; 49: No. 1, 190-6(Jan 1972).

Tests of the effects of γ radiation on eye color mutation frequencies in Dahlbominus have shown no indication of differences in repair when chronic exposures were compared with acute at three different exposure levels (62.5, 250, and 500 R). Also, an almost exact linear relationship between dose and effect was found when tests with acute exposures (100 R/min) were extended to cover the range from 500 to 15.5 R, indicating that a threshold value at lower levels is improbable. The adult females irradiated in these tests were held until 9 to 13 days of age, when all germ cells were arrested in the mature oocyte stage, thereby eliminating varying sensitivity to mutation during prolonged chronic exposures. The sensitivity of Dahlbominus oocytes has proved to be approximately five times higher than that found in mice. The doubling dose for Dahlbominus, where the induced frequency is twice the spontaneous frequency, appears to be approximately 24 R. (auth)

23150 ACUTE LETHALITY IN IRRADIATED FLOUR BEETLES: EVIDENCE AGAINST A ROLE OF BACTERIAL INFECTION. Ducoff, H. S.; Mortimore, Betty W.; Vaughan, Alice P.; Crossland, Janice L. (Univ. of Illinois, Urbana). J. Invertebr. Pathol.; 18: No. 3, 344-52(1971).

The time course of mortality and the mean survival time of flour beetles dying after x-irradiation varied slightly in different strains and species. Within a given strain, however, both minimum and mean survival time were independent of dose over a wide range of exposures and independent of percent mortality. These findings suggest the operation of a single mode of death in irradiated beetles, in contrast to the "hierarchy of modes of death" recognized in irradiated mammals. Invasion of blood and tissues by enteric bacteria which gain entrance through the damaged intestinal lining, and subsequent spread of such infection, have been implicated in the lethal syndrome of irradiated mammals. The present investigation indicates that bacterial invasion does not contribute to the death of irradiated beetles. This conclusion is based on the lack of influence on survival of administration of neomycin at levels which eliminated virtually all bacteria from the insects, crowding or isolation, or maintenance of irradiated beetles on medium in which other beetles previously had been raised. In addition, analysis of the distribution of deaths among a large number of vials each containing a small number of beetles disclosed no deviation from expectation based on random distribution; thus it seems unlikely that there is any spread of contagion within vials. (auth)

23151 PRODUCTION OF MONOSOMIC-TRISOMIC INDIVIDUALS IN DROSOPHILA MELANOGASTER BY X-IRRADIATION OF IMMATURE OOCYTES. Traut, H.; Scheid, W. (Univ., Muenster, Ger.). Mutat. Res.; 13: No. 4, 429-32(Dec 1971).

Cerebral ganglia of F_1 larvae originating from complete or partial X chromosome loss induced by x rays in immature oocytes of wild type females were analyzed. The chromosomes were stained with quinacrine for fluorescence microscopical analysis and later stained with orcein. A positive correlation was found between the x-ray induction of X chromosome loss and chromosome IV nondisjunction. (H.L.W.)

23152 FINE STRUCTURAL DAMAGE IN THE SOMATIC TISSUES OF GAMMA-IRRADIATED HOUSE FLY. I. FLIGHT MUSCLES. Bhakthan, N. M. G.; Nair, K. K. (Simon Fraser Univ., Burnaby, British Columbia). Ann. Entomol. Soc. Amer.; 65: No. 2, 504-8(15 Mar 1972).

Irradiation of the male house fly (Musca domestica) with γ induced considerable changes in the fine structure of the fibrillar flight muscles. Within four hrs after irradiation with 10,000 rads, the sarcoplasmic and transverse tubular system showed vacuolation. The extent of vacuolation increased with increase in dose. These vacuoles disappeared in the 10,000- and 20,000-rads irradiated groups by the 6th and 10th day, respectively, but remained in the flight muscles of flies irradiated with 40,000 rads. Damage to the flight muscle mitochondria became evident two days after irradiation with 20,000 and 40,000 rads. Disruption of the cristae was followed by loss of material from the matrix. Eighteen days after irradiation most of the mitochondria in the 20,000-rads-irradiated group appeared to have repaired this damage, whereas in the 40,000-rads-irradiated group the damage persisted, and many mitochondria contained whorllike structures. Moreover, the mitochondria showed accumulation of glycogen granules. The significance of these findings with respect to aging in the house fly is discussed. (auth)

23153 UV IRRADIATION OF POLAR CELLS OF DROSOPHILA MELANOGASTER EGGS. IV. STUDY OF AN UNSTABLE DOMINANT-SEMILETHAL MUTATION LOCALIZED ON THE THIRD CHROMOSOME. Prudhommeau, Claude (Laboratoire de Biologie General, Orsay, France). Mutat. Res.; 14: No. 2, 193-205(Feb 1972). (In French).

In the course of an experiment involving uv irradiations of polar germ cells in eggs, an interesting mutant was obtained. The male in which it was observed was heterozygous for six chromosome III genes. A test-cross of this male to the stock homozygous for the six chromosome III genes produced progeny among which there was a large deficit of wild parental class and the presence of crossovers was observed. The first studies of this mutant permit the following general conclusions: Localized on the third chromosome near the centromere, this mutation acts as a dominant semilethal and expresses itself in males and females, and and has three principal characteristics: unstability; existence in several genetic states; and relation to genetic recombination in the region of its localization. Some questions concerning the origin of this mutation, the number of genetic states, the possible reversibility of some changes of states, the stage of spermatogenesis during which these changes appear, and the presence of crossovers in male progenies are discussed. The following hypothesis is proposed: The mutation originated in a redundant region. The changes of states could correspond to a recombination between sister chromatids during meiosis. During mitosis a recombination-like unequal crossing-over could give rise to crossovers observed in the male progeny. (auth)

23154 FRACTIONAL AND COMPLETE MUTATIONS FOLLOWING IRRADIATION OF DROSOPHILA SPERMATIDS IN NITROGEN OR IN OXYGEN. Munoz, E. R. (Univ. of Leiden. Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res.; 14: No. 2, 185-92(Feb 1972).

The induction of complete and fractional mutations at the yellow, white, singed, and dumpy loci was studied in Drosophila melanogaster spermatids irradiated with 1000 R of x rays in O_2 or in N_2. The results show that: the frequency of fractionals at the y, w, and sn loci does not differ significantly from the spontaneous values and this is so, irrespective of the gaseous atmosphere used during the irradiation; the oxygen enhancement ratio (O.E.R.) for the induction of complete mutations at these loci is 3.1; at the dp locus the difference between the frequency of fractional mutations in the irradiated series and that in the controls is on the borderline of significance; and at the same locus the O.E.R. for completes is high, being about 5.4. The proportion of dp fractionals among dp mutations appears to decrease from 43.5% after 1000 R in N_2 to 26.2% after the same exposure in O_2. While this observation may be interpreted as being consistent with the predictions of either the lethal-hit hypothesis or the repair hypothesis under certain conditions, the role of other factors that might cause a similar shift in the proportion must be taken into consideration. The data on the induction of fractional and complete mutations at the dp locus, considered in conjunction with the data of other loci from this study as well as those published by other investigators, suggest that the fractional and complete mutations detected after irradiation may have independent origins. With the exception of the dp locus, the evidence for the induction by radiation of fractional mutations at other loci investigated is not convincing. The high O.E.R. of 5.4 estimated for the induction of dp completes is thought to result from the induction kinetics for these mutations, which, even at the exposure of 1000 R in O_2 may have a sizeable two-hit component. (auth)

23155 RADIOBIOLOGY OF ARTEMIA: RADIATION EFFECTS AND PLOIDY. Metalli, Pietro; Ballardin, Elda (CNEN-CNS, Rome). Curr. Top. Radiat. Res. Quart.; 7: No. 2, 181-240 (Jan 1972).

Some of the main biological features of Artemia salina are briefly reviewed and the oogenesis in parthenogenetic strains is described in more detail, in order to show the advantages and limitations of the brine shrimp as material for studies on specific problems in radiobiology. Although the quantitation of radiation lethality of diapause embryos is relatively easy, the interpretation of this effect and the significance of their extremely high radioresistance are not readily appreciable, mainly because little information is available on the physiology of embryogenesis. Nevertheless, a genetic control of the sensitivity was demonstrated, tetraploid eggs being slightly but consistently more resistant than diploid. The ploidy effect is much more pronounced when developing oocytes are irradiated and total embryo lethality is scored; sensitivity can be measured in terms of inverse slopes of exponential dose–effect relationships and quantitative estimates were obtained. The naturally synchronous maturation of the oocytes and the possibility of recognizing defined meiotic stages on inspection, have also allowed the definition of the radiosensitivity spectrum of meiosis in parthenogenetic animals. The stages with condensed chromosomes (metaphase and diakinesis) are much more resistant than the diffuse (diplotene) stage, and tetraploid oocytes are about 2 to 3.5 times as resistant as diploid, depending on the stage at irradiation. The oocytes show a definite although incomplete recovery from sublethal damage, as shown by splitting the radiation dose within times and at meiotic stages during which the cells do not progress in their maturation cycle. The concept of repair efficiency is proposed to give an estimate of the relative amount of sublethal damage repaired, and by this criterion no difference is shown by the oocytes of all strains tested, thereby strongly suggesting that the basis for the ploidy-dependent radioresistance is not correlated with a greater ability for repair. A few hypotheses are offered for discussion of both ploidy and meiotic stage effects. If young adults are irradiated, the life-span-shortening effect of radiation seems totally independent of ploidy and genotype, suggesting that in lower organisms and for degrees of ploidy of two or higher, the role of radiation damage to genetic systems of somatic cells in the development of this

relatively late radiation action is very small and cannot be detected with the experimental designs used so far. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 22759, 23072, and 23087.

23156 (CEA-Bib-202) CALCULATION OF ABSORBED DOSES IN TISSUES IN CASE OF CONTAMINATION BY GAMMA-EMITTING RADIOELEMENTS. Nikpay-Aslie, Parviz; Menoux, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 48p. (In French). Dep. NTIS (U. S. Sales Only).

When calculating absorbed doses for biologically distributed gamma-emitting radioisotopes the traditional methods (inverse-square, exponential attenuation factors) lead to rough results as they cannot adequately consider the dose from scattered radiation or the effects of boundaries. Such drawbacks disappear when the latest estimations of build-up factors as well as the new calculation methods by means of Monte-Carlo sampling are used. These new methods can be introduced thanks to the definition of new concepts such as absorbed fraction, specific absorbed fraction, equilibrium dose constant, which allow to fit more closely to the radiobiological models to be found in biological and medical applications. (auth)

23157 (SWRHL-503-r) WHOLE-BODY COUNT OF ^{187}W IN PHS PERSONNEL FOLLOWING THE SCHOONER EVENT. Eckert, John A. (Western Environmental Research Lab., Las Vegas, Nev.). [1971]. 18p. (CONF-711104-2). Dep. NTIS.

From Symposium on the assessment of radioactive organ and body burdens; Stockholm, Sweden (22 Nov 1971).

The SCHOONER Event, conducted at the Nevada Test Site, December 8, 1968, released radioactive effluent into the environment. Whole-body counts were performed on thirty one Public Health Service personnel who participated in this cratering experiment. Tungsten-187 appeared in the resultant spectra as the only contaminant. Repeated whole-body counts were performed during the week following exposure to determine the magnitude of individual burdens. The maximum burden measured, 25 μCi, correlates to an estimated dose to the large intestine of approximately 1 rad. Absorbed dose calculations, based on physiological parameters taken from the International Commission on Radiation Protection Manual II, indicate a dose conversion factor of 32 mrad per μCi tungsten-187 ingested. A whole-body scan performed eight hours after exposure confirmed the presence of tungsten-187 in the GI tract of one individual and yielded an upper limit calculation on the maximum possible absorbed dose to the lung of 6 mrad/μCi ^{187}W retained. (auth)

23158 (SZS-15/71 (pp 17-27)) VALUE OF CHROMOSOME ANALYSIS AFTER INCORPORATION OF RADIOACTIVE MATERIALS. Grigoroff, L.; Gensicke, F. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (In German).

The evaluation of the literature shows that after internal uptake of radioisotopes the same types of chromosomal changes are observed in animals and in humans. Increasing internal irradiation causes an increase of chromosome aberrations. At present it is not possible to give a mathematical representation of the ratio of the number of chromosome aberrations to the absorbed dose or to determine the chromosomal changes caused by the internal irradiation from a certain radionuclide as a function of the absorbed amount of radioactivity and of time. (auth)

23159 (UCRL-73195) DOSE TO MAN VIA FOOD-CHAIN TRANSFER RESULTING FROM EXPOSURE TO TRITIATED WATER VAPOR. Anspaugh, L. R.; Koranda, J. J.; Robison, W. L.; Martin, J. R. (California Univ., Livermore. Lawrence Livermore Lab.). 3 Dec 1971. 31p. (CONF-710809-12). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

Past efforts to predict the radiation dose to man as a result of possible food-chain contamination following the release of THO vapor have been based upon models more appropriate for the release of radionuclides which differ substantially from THO in the dynamics and pathways of ecological transport. Field studies in conjunction with Project Rulison and controlled exposure experiments indicate that such models overpredict the dose to man by orders of magnitude. Data from these and other pertinent experiments are used to derive a more realistic, simple model which may be used to predict the dose to man via inhalation plus absorption and via the ingestion of vegetables, milk, and meat. Both acute and chronic exposures are considered. Limitations of the model and extension of the model to exposures involving the wet deposition of THO are discussed. (auth)

23160 EFFECTS OF RADIOACTIVE FALLOUT ON THE PREGNANT WOMAN AND THE FETUS. Nishiwaki, Yasushi (Tokyo Inst. of Tech.); Yamashita, Hisao; Honda, Yoshihide; Kimura, Yuichiro; Fujimori, Hayami. Int. J. Environ. Stud.; 2: No. 4, 277-89(Jan 1972).

The levels of ^{90}Sr and ^{137}Cs in human placenta, fetus and diet were determined by radiochemical methods during the period from March 1966 to December 1968. The possible effects of these radionuclides on the pregnant woman and the fetus are discussed. The metabolic characteristics of both ^{90}Sr and ^{137}Cs are also discussed on the basis of estimates of discrimination factors and observed ratios of these radionuclides. As a result of the analyses, the dose rate to the human placenta resulting from deposition of ^{90}Sr in the organ was estimated at about 0.003 mrem/month and that of ^{137}Cs at about 0.013 mrem/month. The dose rate to the total body resulting from the body burden of these radionuclides in the mother was estimated at about 0.012 mrem/month. These values are much smaller than the monthly dose from ^{40}K normally existing in the body. It is difficult to draw definitive conclusions concerning the possible correlation between the ^{90}Sr fallout and the annual changes of infant mortality rates in Japan. (auth) (UK)

23161 ESTIMATION OF THE ABSORBED DOSE IN PLACENTARY SCINTIGRAPHY WITH ^{113m}In. Montesanti, M. I.; Troncone, L.; Garcea, N.; de Rossi, G. (Catholic Univ. of the Sacred Heart, Rome). Minerva Fisiconucl.; 15: No. 2, 65-76 (Apr-Jun 1971). (In Italian)

On the basis of direct experimental data, an estimation was made of the dose absorbed by the mother and fetus during scintigraphy for placenta localization with ^{113m}In. The contribution to the dose by $^{113}Sn-^{113m}In$ was considered in the calculation. The results obtained with the traditional methods did not vary substantially from those obtained with the absorbed fraction method. The results showed that the dose absorbed by mother and fetus was within acceptable limits. (J.S.R.)

23162 RADIOIODINE THERAPY TO OUT-PATIENTS: THE RADIATION HAZARD. Buchan, R. C. T.; Brindle, J. M. (Plymouth General Hospital, Devon, Eng.). Brit. J. Radiol.; 44: No. 528, 973-5(Dec 1971).

Tabulated results are presented of TLD monitoring of the γ radiation dose received by 54 persons who were the members of households of out-patients undergoing ^{131}I therapy. The significance of the results, taken in conjunction with the results of an earlier contamination survey, are discussed. Rationalized and simplified proposals are presented as a basis for control of radiation hazard involved in radioiodine out-patient treatment. (auth) (UK)

23163 EXPERIMENTALLY-DETERMINED ENERGY ABSORPTION FOR GAMMA SOURCES IN TISSUE-EQUIVALENT CYLINDERS. Hubiak, Richard John. Cincinnati; Univ. of Cincinnati (1971). 96p. University Microfilms Order No. 72-1418.

Thesis.

With the expanded use of radioisotopes, one area of concern is in better determining the dose received by humans from radionuclides deposited in the body. An experimental procedure was developed to obtain absorbed fractions for small finite tissue-equivalent right cylinders containing a point source gamma emitter. The radionuclides employed in this study were iridium-192 and cobalt-60. Phantoms used in this study were right cylinders with 3, 5, and 10 centimeter radii, and 5, 10, 15, and 20 centimeter heights. The phantom material was a thermosetting isocyanate rubber that was equivalent to human tissue in terms of radioabsorption. Doses at the surfaces were measured by thermoluminescence dosimetry (lithium fluoride). From the dose measurements made at specific points on the surface of the cylinders, the energy at intervals over the entire surface of the cylinders was calculated. Using graphical integration, the total energy emitted from cylinders was determined. Knowing the total energy emitted from the gamma point source, it was then possible to calculate absorbed fractions, emitted energy-transmitted energy/emitted energy, for specific cylinder sizes and for each of the radionuclides used. The results from this study indicate that as the mass of the cylinder increased, the absorbed fraction increased. The experimental results were compared with those as obtained by theoretical calculations and were found to be in good agreement. (Diss. Abstr. Int., B)

23164 RADIATION EXPOSURE DUE TO NUCLEAR MEDICAL INVESTIGATION AT CHILD'S AGE. Wolf, R. (Univ., Mainz). Monatsschr. Kinderheilk.; 118: No. 6, 221-4(1970). (In German).

The physical, chemical, pharmaceutical, biological, and physiological factors are discussed that influence the radiation exposure after incorporation of radioactive substances. Numerical values for radiation exposure in nuclear medicine are based on: critical organ exposure; whole-body exposure; and gonad exposure. Differences in radiation exposure of adults and children are due to: anatomy; physiology; and particular radiation sensitivity of children's tissues. Those methods are critically considered that can be used in pediatrics. (INIS)

23165 ESTIMATES OF DOSE TO NORTHERN HEMISPHERE POPULATION GROUPS FROM ^{85}Kr EMITTED BY A SINGLE NUCLEAR FUEL-REPROCESSING PLANT. Knox, Joseph B.; Peterson, Kendall R. (Univ. of California, Livermore). Nucl. Safety; 13: No. 2, 130-5(Mar-Apr 1972).

The radiation dose to Northern Hemisphere population groups from ^{85}Kr emitted by a typical nuclear fuel reprocessing plant was estimated for various distances and times, including the global equilibrium population dose resulting from a constant rate of emission. The total population dose at any location depends on both the proximity to the plant and the population of the area affected. The largest population dose occurs in Asia, principally because of its dense population, but this is a small fraction of that received from natural radioactivity. The next largest dose is within 1000 km of the source, and the smallest doses are in polar and equatorial latitudes. (auth)

Animals

Refer also to abstract 23101.

23166 (AED-CONF-71-100-53) EARLY AND LATE EFFECTS OF INCORPORATED ^{224}Ra IN MICE. Goessner, W. (Gesellschaft fuer Strahlen- und Umweltforschung, Munich (West Germany). Institut fuer Biologie); Hindringer, B.; Hug, O.; Luz, A.; Mueller, W. A. May 1971. 16p. (CONF-710901-538). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The long-term effects of short-lived radionuclides following incorporation in animals were investigated. Data are reported from studies on the effects of ^{224}Ra in mice. The short-lived ^{224}Ra was found to produce osteosarcomas after single intraperitoneal injections in mice. In the dose range between 5 and 50 microCi/kg (about 150 and 1500 rads mean skeletal dose) female mice showed an osteosarcoma incidence of about 15% over the whole dose range. In males the tumor incidence was lower and increased with dose from 2 to 8%. The skeletal distribution and the morphological differentiation of the osteosarcomas varied with dose. In the higher dose range the jaws were the main location of the sarcomas. These tumors showed a distinct morphological structure different from the tumors in other skeletal sites. Early severe tissue damage after the administration of larger amounts of ^{224}Ra seemed to decrease the osteosarcoma incidence. Bone fracture nine days before incorporation of ^{224}Ra did not seem to increase significantly the bone tumor incidence. The incidence of most soft tissue tumors was low after treatment with ^{224}Ra. (auth)

23167 (ORO-686) FALLOUT RADIATION EFFECTS ON LIVESTOCK (PART A) AND FOOD CROPS (PART B). Annual Report, November 1, 1970-June 30, 1971. Sasser, L. B.; Bell, M. C.; West, J. L.; Killion, D. D.; Constantin, M. J. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT-40-1-GEN-242. 44p. Dep. NTIS.

The primary hematological response in sheep and cattle following the ingestion of simulated fallout radiation (sand particles labeled with ^{90}Y and ^{46}Sc) was the drop in platelet and white cells from whole-body gamma exposure alone and in combination with skin and gastrointestinal exposures. Skin and gastrointestinal irradiation caused minor blood changes which appear to be insufficient in magnitude to account for the high mortality from the combined exposures. Data on surviving cattle show that skin and gastrointestinal irradiation severely reduced animal productivity. Sheep fed 44 to 88 μ fallout simulant responded similarly to those fed larger particles. Rate of passage of the simulant was reduced by increasing the level of fallout simulant fed. Swine were less sensitive to gastrointestinal fallout simulant alone and in combination with whole-body exposure in comparison with cattle and sheep. Varieties of corn (Zea mays) and of soybean (Glycine max) were exposed to ^{60}Co γ radiation and grown to maturity under outdoor conditions. Corn was more sensitive to irradiation than soybeans and yield was more severely affected than survival and height. Exposures delivered at a high rate were more effective than the same exposures delivered at a low rate. Plants irradiated in early developmental stages were somewhat more tolerant than at later developmental stages; yield was most severely affected during the early reproductive stage. Varietal difference in radiosensitivity was greater in corn than in soybeans. (auth)

23168 ALTERATIONS OF THYROID MORPHOLOGY IN MICE BY RADIOACTIVE PHOSPHORUS: LATE EFFECTS. Dev, P. K.; Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 142: No. 4, 486-9(Oct 1971).

The long-term effect of radiophosphorus was studied in the thyroid gland of Swiss albino mice. Adult males weighing 24 to 27 g were given ^{32}P, 3 μCi/g body weight, and autopsied at 15, 30, and 60 days after injection. Thyroid epithelium shows radiolesions at all the stages, but maximum desquamation and distortion of epithelium are marked at a 30-day interval. There is evidence of the denaturation of colloid, too. In a few cases, areolar connective tissue replacing the follicular epithelium was noticed. Blood vessels show a thickened nature. The 60-day-treated thyroid reveals little recovery over the 30-day interval. It is suspected that there is a damage-recovery process in the thyroid gland. (auth)

23169 MARKING RED-SCALE WITH ^{14}C AND ITS EFFECT ON REPRODUCTION AND SURVIVAL. Robertson, Gillian (Univ. of Adelaide). Entomol. Exp. Appl.; 14: No. 4, 449-56 (1971).

The possibility of using ^{14}C to mark red-scale for ecological studies has been investigated. Citrus leaves were labelled with ^{14}C to have an activity in the range 3 to 300 μ Ci gm^{-1}. All insects feeding on these leaves became radioactive. Mature females had an activity of 5000 to 160,000 c.p.m., mature males an activity of 1000 to 16,000 c.p.m. and the progeny of the females labelled to the level of 10,000 c.p.m. had an activity of 10 to 30 c.p.m. Higher levels of activity affected the development and fecundity of the insects. High mortality was observed in first-instar larvae which had an activity $\geq$10,000 c.p.m. and in second-instar larvae which had an activity $\geq$20,000 c.p.m. Fertilized females which had an activity of 30,000 c.p.m. did not reproduce. The marking method has been extended to the mass-rearing of labelled insects on green melons which have incorporated ^{14}C during photosynthesis. (auth)

23170 EFFECT OF AGE ON THE MORPHOLOGIC RESPONSE OF THE RAT THYROID TO IRRADIATION BY ^{131}I. Sikov, M. R.; Mahlum, D. D.; Howard, E. B. (Pacific Northwest Lab., Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 49: No. 1, 233-44(Jan 1972).

Prenatal, newborn, weanling, and adult rats were exposed to graded doses of ^{131}I up to and including 3.0 μCi/g. Animals from each age-dose group were killed at 1, 3, and 7 days and at 4 months postexposure. The gross and histopathologic effects were determined and correlated with the previously established radiation doses to the thyroid. The primary effect seen in the younger animals was an inhibition of growth and development of the thyroid; the magnitude of this inhibition was generally proportional to radiation dose. In contrast, degeneration followed by fibrosis predominated in the older animals. The magnitude of these effects was sufficient to account for the previously reported decrease in thyroid function. In the younger animals exposed to 1.0 or 3.0 μCi/g, the trachea underlying the thyroid gland received sufficient radiation dose to inhibit its growth. (auth)

23171 TOXICITY IN THE DOG OF INHALED ^{90}Y IN FUSED CLAY PARTICLES: EARLY BIOLOGICAL EFFECTS. Hobbs, C. H.; Barnes, J. E.; McClellan, R. O.; (and others) (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Radiat. Res.; 49: No. 2, 430-60(Feb 1972).

The toxicity of ^{90}Y in the beagle is being investigated as part of a program to evaluate the biological effects of inhaled radionuclides. Thirty-three beagles were exposed to aerosols of ^{90}Y in fused clay resulting in initial lung burdens (ILB) of 80-5200 μCi ^{90}Y/kg body weight. Cumulative beta radiation dose to the lungs to infinity or death ranged from 990 to 55,000 rads. Twenty-one dogs with ILBs from 670 to 5200 μCi/kg and beta radiation doses to lung ranging from 8400 to 55,000 rads died between 7.5 and 163 days postexposure. Clinical signs included progressive increase of respiratory rates, abnormal lung sounds on auscultation, progressive weight loss, lymphopenia, and eventual cyanosis. Principal pathological findings were pulmonary and pleural fibrosis, occlusive pulmonary vascular lesions, metaplasia and/or hyperplasia of terminal bronchiole and alveolar epithelium, right-heart dilatation and hypertrophy. Infarcts of the right atria were found in some animals. All dogs with ILBs of 460 μCi/kg or less and cumulative dose to lung of 5700 rads or less are still alive at 402-465 days postexposure and show no detectable clinical effects and no changes in either thoracic radiographs or blood gas and pulmonary function parameters. These dogs will be observed for their lifespan. (auth)

Plants

23172 BIOLOGICAL EFFECTS OF RADIOACTIVE DECAY: THE ROLE OF THE TRANSMUTATION EFFECT. Krisch, Robert E.; Zelle, M. R. (Argonne National Lab., Ill.). Advan. Radiat. Biol.; 3: 177-213(1969).

A review is presented of the role of the transmutation effect in biological effects of radioactive decay. The physical and chemical backgrounds of events accompanying beta decay of some isotopes of current biological interest are reviewed. The biological effects of decay of ^{14}C, ^{32}P, and ^{3}H are reviewed with emphasis on genetic effects and effects on cellular viability. The biological effects of ^{35}S and ^{90}Sr are also reviewed and a discussion is presented of cellular repair after transmutation injury. (H.L.W.)

Microorganisms

23173 REPAIR OF ^{32}P DECAY-DAMAGED PHAGE λ IN VARIOUS RADIATION-SENSITIVE STRAINS OF E. COLI K12. Glickman, Barry W.; Walker, Katherine J.; Roersch, Arthur (Medical Biological Lab. TNO, Rijswijk, Netherlands. Leiden State Univ.). Mutat. Res.; 14: No. 3, 265-70(Mar 1972).

A number of isogenic radiation-sensitive strains of E. coli K12 were tested for their ability to reactivate ^{32}P decay-damaged λ phage. The loss of the Rec, Uvr, Exr and Ror functions does not affect the reactivation of the damaged phage. In contrast, the loss of the Pol function reduces the reactivation efficiency. It is estimated that polAl strain is 5 times less efficient in the repair of single-strand breaks than the pol^+ strain. (auth)

Nuclide Kinetics and Toxicology

23174 (RLO–1750-84) RADIOACTIVITY IN JUVENILE COLUMBIA RIVER SALMON: A MODEL TO INTERPRET MOVEMENT AND FEEDING HABITS. Romberg, Gerald P.; Renfro, William C. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1969]. 16p. Dep. NTIS.

Juvenile salmon (Oncorhyncus sp.) in the lower Columbia River took up characteristic amounts of radioactive phosphorus and zinc originating from the plutonium production reactors at Hanford, Washington. The ^{32}P specific activities (n Ci ^{32}P/g P) and ^{65}Zn activities (p Ci ^{65}Zn/g ash) of individual salmon provided clues regarding their movements and feeding behavior. (auth)

23175 STUDIES ON THE ACCUMULATION MECHANISMS OF RADIOISOTOPES USED IN TUMOR DIAGNOSTIC. Anghileri, Leopoldo J. (Rhur Univ., Essen). Strahlentherapie; 142: No. 4, 456-62(Oct 1971).

The calcium metabolism-determined accumulation of radioisotopes used in scintigraphic diagnosis of tumors was studied both in vitro and in vivo. ^{67}Ga, ^{85}Sr, ^{51}Cr, and ^{32}P showed an interaction with insoluble calcium that indicates a physicochemical absorption as a probably very important preliminary stage in the in vivo accumulation. While ^{67}Ga appears to be deposited by chemical replacement of calcium from its insoluble forms, ^{85}Sr showed a behavior indicating that it mimics calcium during its localization in calcium metabolic active tissues. Complexed ^{51}Cr is likely to be incorporated by coordination binding while ^{32}P, besides its metabolic incorporation during phosphorylation reactions, can be exchanged by insoluble calcium phosphates. ^{99m}Tc and ^{197}Hg showed no incorporation likely to be related with abnormalities of the calcium metabolism in tumors. (auth)

23176 INTESTINAL ABSORPTION OF METAL IONS, TRACE ELEMENTS, AND RADIONUCLIDES. Skoryna, S. C.; Waldron-Edward, D. (eds.). Elmsford, N. Y.; Pergamon Publishing Company (1971). 441p. $19.50.

Separate abstracts were prepared for four of the 25 papers included in the book. The other papers discuss topics related to the physiology of absorption and transport, the absorption of specific metal ions, or factors affecting metal ion absorption and transport. (E.R.B.)

For abstracts of individual papers see: 23113, 23179, and 23196–23197.

Man

Refer also to abstract 25033.

23177 (LBL–584) CALCULATION OF HUMAN BONE AND URINARY ^{18}F CLEARANCE AFTER SINGLE INTRAVENOUS INJECTION. Parker, H. G. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 14p. Dep. NTIS.

A two-compartment mathematical model and a detailed method of calculation are presented for determination of bone and urinary ^{18}F clearance from blood of humans following a single intravenous injection of the nuclide. The calculation is part of an assessment of bone blood-flow currently employed as a clinical research procedure. It is based on multiexponential fitting to a three-hour blood activity curve and on measurement of activity in a single cumulative urine sample. The independence of the clearances from some other details of the two-compartment model is stressed, and the computation is simplified, facilitating calculation by hand or by using a very simple computer program. The method also appears useful for measurement of clearances of certain other rapidly-incorporated bone-seeking materials. (auth)

23178 (NP–19201) EMERGENCY TREATMENT OF WOUND CONTAMINATED BY A MIXTURE OF FISSION PRODUCTS. Pasquier, Ch.; Ducousso, R.; de Regnauld, M. (Centre de Recherches du Service de Sante des Armees, Percy (France). Division de Radiobiologie Experimentale). 13 Sep 1971. 29p. (In French). Dep. NTIS (U. S. Sales Only).

In peace time, contaminated wounds occur most frequently as the result of an accident at work using a glove box, the hand and forearm being particularly concerned. Alpha emitting contaminating elements have been studied in detail, whereas β and γ emitters have been less frequently studied. The treatment of a contaminated wound necessitates, first, an emergency treatment at the place where the accident occurred; the treatment must render the element insoluble or produce chelation in the wound, it must act by chelation on the circulating blood system, and it must produce blocking in the critical organs. In the case of ^{85}Sr, the use of Sr rhodizonate is recommended. (France)

23179 INTESTINAL ABSORPTION OF STRONTIUM. Volf, Vladimir (Inst. of Radiation Hygiene, Prague. Nuclear Research Center, Karlsruhe, Ger.). pp 277-92 of Intestinal Absorption of Metal Ions, Trace Elements, and Radionuclides. /Skoryna, S. C. (ed.). Elmsford, N. Y.; Pergamon Publishing Co. (1971).

The absorption of strontium from different parts of the intestinal tract in the rat depends on the rate of absorption in each location or segment and on the amount available for absorption. The amount of strontium absorbed also depends on the motility of each segment and on the physicochemical properties of the intestinal contents such as pH. The absorption and excretion of strontium should always be considered in relation to calcium and to other alkaline earths as well as phosphorus and perhaps fluorine. Certain natural organic dietary constituents such as lactose, lysine, and vitamins as well as neurotropic agents and irradiation are known to influence strontium absorption. It is possible to reduce substantially the body burden of radiostrontium shortly after its ingestion, with single oral doses of sulphates, phosphates, and alkaline earths. This does not mean, however, that reduced strontium uptake is caused by lowered absorption only since the intestinal and renal excretions of absorbed strontium may also be affected. Alginates, high molecular-weight uronic acids derived from brown marine algae, appear to be suitable for short- and long-term reduction of intestinal absorption of radiostrontium; the binding appears to be highly selective as calcium binding does not occur to a degree sufficient to interfere with dietary requirements and administration of calcium alginate is at least equally effective. The data obtained from human populations indicate that in children, depending on age, a higher proportion of ingested strontium is absorbed than in adults, presumably due to lower absorptive discrimination against strontium. The absorption of a single radiostrontium dose in man is reduced by the presence of food or by a calcium carrier in the intestinal canal, as well as by barium sulphate or sodium alginate. (auth)

23180 DETERMINATION OF THE INTAKE COEFFICIENT OF ISOTOPES IN THE DIGESTIVE TRACT BY THEIR ELIMINATION. Ramzaev, P. V. Gig. Sanit.; No. 8, 65-70(Aug 1971). (In Russian).

The two chief methods of determining the coefficient of isotopic intake are compared, and refinements in the mathematical definition are suggested. Data from several different workers are used to carry out sample calculations with the improved equation. (K.S.W.)

23181 INTAKE OF ^{90}Sr AND ^{137}Cs WITH FOOD BY THE POPULATION OF THE SOVIET UNION FROM 1967 TO 1969. Knizhnikov, V. A.; Petukhova, E. V.; Barkhudarov, R. M. (Inst. of Biophysics of the Ministry of Health, Moscow). Gig. Sanit.; No. 8, 54-9(Aug 1971). (In Russian).

A gradual fall in the extent of contamination of most of the food products with ^{90}Sr and ^{137}Cs was noted in the period from 1967 to 1969. The rate of fall of contamination of bread, fish, potatoes, and meat with ^{137}Cs was much more significant than that of contamination with ^{90}Sr. In 1969, in comparison with that in 1967, the intake of ^{90}Sr by the population of the Soviet Union decreased by 30% and that of ^{137}Cs by almost 60%. The level of intake of ^{90}Sr by the population in 1969 amounted to about 6% and that of ^{137}Cs to 1.2% of the permissible intake of these isotopes according to the 1969 standard of radiation safety. (auth)

23182 CONSIDERATION OF STABLE IODINE IN THE ENVIRONMENT IN THE EVALUATION OF MAXIMUM PERMISSIBLE CONCENTRATIONS FOR ^{129}I. Tadmor, Jacob (Soreq Nuclear Research Centre, Yavne, Israel. Tel-Aviv Univ., Israel). Radiol. Health Data Rep.; 12: No. 12, 611-14(Dec 1971).

An increase in the content of ^{129}I in the atmosphere due to release from nuclear fuel reprocessing plants is predicted, based on projected figures for the expansion of the nuclear industry to the year 2000. It is pointed out that stable iodine is also released from nuclear fuel reprocessing plants. Consideration of the relationship between the concentration of stable and radioactive isotopes in an equilibrated environment revealed that the maximum permissible concentration (MPC) values for ^{129}I might need revision. A test computation was performed on the MPC of ^{129}I in atmosphere and the corresponding maximum permissible burden in the human thyroid, taking into consideration the ratio between the mass concentration of the radioactive and total isotopes. Data on the half-time equilibrium for ^{129}I via different food chain pathways to various human tissues were used in the computation. It was concluded that, based on the MPC value of 6×10^{-11} Ci/m^3 for the nonoccupational population, the ^{129}I burden of the human thyroid in the year 2000 could reach a level about 14-fold higher than the maximum permissible burden. (C.H.)

23183 BONDS OF METHYLENE BLUE TO ERYTHROCYTES OF URANIUM MINERS. Nosek, J. (Inst. of National Health in Uranium Industry, Pribram, Czech.). Cas. Lek. Cesk.; 110: No. 14, 313-16(2 Apr 1971). (In Czech).

A study is presented on the progressive decoloring of methylene blue by the suspension of erythrocytes, carried out on uranium miners. The results of this and of two preceding studies show a different content of pyridinanedindinucleotides in the erythrocytes of uranium miners, as compared with controls. The reason is assumed to be the contamination of erythrocytes by uranium. (NSA of Czech)

23184 BODY BURDENS OF ^{137}Cs AND ^{40}K IN THE JAPANESE POPULATION. Katsunuma, Haruo; Yoshizawa, Yasuo (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 31: No. 1, 1-6 (Apr 1971).

About 2000 Japanese were sampled for this study. Body burdens of ^{137}Cs and ^{40}K in the Japanese population were measured with a whole-body counter. Sex and age of the subjects, ranging in age from 6 to 87 years, were evenly distributed. The survey took 2 yrs to complete. The decreasing rate of body burdens of ^{137}Cs during the 2 yrs was taken into account, and the necessary correction was made. Number of subjects showed in tables by age and sex. The potassium concentration was recorded as grams of potassium per kilogram of lean body mass (LBM). The body burdens of ^{137}Cs were expressed as radioactivities per kilogram of body weight per gram of potassium. From the values obtained in this study, the genetically significant doses delivered by body burdens of ^{137}Cs and ^{40}K to the Japanese population were calculated as 20.61 ± 0.50 mRem/yr and 0.49 ± 0.05 mRem/yr respectively (the values of August 1967 were used for the calculation of the dose). (Japan)

23185 ABSORPTION AND RETENTION OF COBALT IN MAN BY WHOLE-BODY COUNTING. Smith, T.; Edmonds, C. J.; Barnaby, C. F (University Coll., London). Health Phys.; 22: No. 4, 359-67(Apr 1972).

Retention of ^{60}Co given intravenously or orally as $^{60}CoCl_2$ to human subjects was measured by whole-body counting for periods of up to 1018 days. Intravenous ^{60}Co was retained for long periods, as much as 9 to 16% of the dose being eliminated only with a biological half-life of about 2 yr. The absorption of orally administered $^{60}CoCl_2$ depended on several factors, especially on the amount of stable cobalt given. Only 5% or less of a trace dose (containing less than 1 μg Co) was absorbed but this increased to more than 20% when larger quantities of stable cobalt (1.2 mg) were given. The absorbed fraction of an oral dose was apparently retained by the whole body in a similar way to ^{60}Co given intravenously. Results of serial counts over the liver using a collimated NaI detector, indicated that ^{60}Co was concentrated in this organ in excess of the average whole-body concentration even in subjects measured after 1000 days. The results indicated that the amount of ^{60}Co present in the liver was, on average, about one fifth of the total body content. (auth)

Animals

Refer also to abstracts 22796 and 23053.

23186 (AEC-tr-7299) MARINE RADIOECOLOGY. Polikarpov, G. G. (ed.). Translation of Morskaya Radioekologiya, Kiev, Izdatel'stvo Naukova Dumka, 1970. 348p. Dep. NTIS.

Research techniques, many of which are applicable in various branches of marine biology and oceanography, are described. Results are reported from studies on the dynamics and nature of exchange of radioactive and chemical substances between hydrobionts and the environment; the distribution of radionuclides in organism of marine fauna; and the radiosensitivity of mitosis in fish embryos. Composite data on the radioecology of seas and oceans are presented. Emphasis is placed on the transport of ^{90}Sr in water and organisms of the Black and Red Seas, and the content of ^{90}Sr in fish in the Atlantic and Indian Oceans. (368 references) (C.H.)

23187 (CEA-R-4206) GAMMA-RAY SPECTROMETRY EXPERIMENTS WITH LARGE FARM ANIMALS. Daburon, Francois; Remy, Jacques; Grillon, Gerard; Tricaud, Yves; Nizza, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 103p. (In French). Dep. NTIS (U. S. Sales Only).

A survey was made of the various types of whole-body radiation monitors for large farm animals reported in the literature. Monitoring facilities developed for sheep, swine, and cattle are described from the point of view of radiation detection, containment of the animals, and phantoms used for calibration. The problems of radioisotope distribution in the body were carefully studied in order to try and show the changes that would affect the counting geometry. Some examples given include: iodine metabolism in dairy cattle, assessment in the fetuses and body burdens following the administration of ^{131}I; rate of transit of an ingested insoluble compound ($^{131}BaSO_4$); and the determination of the site of uptake of radionuclides (^{177}Lu and ^{141}Ce) by the interpretation of the scanning data. (auth)

23188 (EUR-4741) MOVEMENT OF CERTAIN ISOTOPES IN ANIMALS AND MAN. Annual Report, 1970. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 36p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 6.65.

Investigations on the metabolism of lanthanides and actinides following inhalation or intramuscular injection were carried out in rats. Differences were noticed between ^{238}Pu and ^{239}Pu distribution in tissues. The metabolism of ^{237}Np was similar to that of ^{233}Pa. Several lanthanides and actinides of valence 3 and 4 were compared both for alveolar clearance and removal from bone. The results obtained with actinides of a higher valence were gathered to show the similarities and differences of distribution as compared with actinides of valence 3 or 4. Further progress was made in studies on alveolar clearance and the kinetics obtained in various experimental conditions were analyzed. (auth)

23189 (RLO-1750-55) ^{65}Zn IN BENTHIC INVERTEBRATES OFF THE OREGON COAST. Carey, Andrew G. Jr. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. 27p. Dep. NTIS.

Radioecological studies of benthic invertebrate fauna off central and northern Oregon demonstrate that ^{65}Zn entering the Northeast Pacific Ocean via the Columbia River is concentrated by the sublittoral, bathyal, and abyssal fauna. The ^{65}Zn (PCi/g ash-free dry wt) and specific activity (μCi ^{65}Zn/g Zn) in the fauna decreases fairly regularly with distance from the river and markedly with depth within the first 400 m. The major route of the isotope to the fauna appears to be through the food web. The radioecology of the benthic organisms differs from that of the pelagic fauna. (auth)

23190 (RLO-1750-61) SEASONAL AND AREAL DISTRIBUTIONS OF RADIONUCLIDES IN THE BIOTA OF THE COLUMBIA RIVER ESTUARY. Renfro, William C.; Forster, William O.; Osterberg, Charles (Oregon State Univ., Corvallis. Dept. of Oceanography). [1969]. 42p. Dep. NTIS.

In the Columbia River Estuary ^{65}Zn was present during 1964 to 1968 in measurable amounts in all organisms. Because of the ease with which it could be measured and because of the biological importance of zinc, ^{65}Zn was studied most intensively. Other radionuclides measured at least once in the biota were ^{60}Co, ^{54}Mn,

^{51}Cr, ^{46}Sc, ^{32}P, and some fallout fission products. Plankton net collections, either unsorted or separated into phytoplankton zooplankton, or wood fiber components, usually had relatively high but variable amounts of ^{65}Zn and ^{51}Cr. No seasonal or areal patterns in radioactivity of the plankton could be observed. Levels of radioactivity in animals of the Columbia River Estuary are constantly changing. Indeed, there appears to be no season when the ^{65}Zn specific activities in the biota are not undergoing change. (auth)

23191 (RLO-2227-T-12-1) ^{65}Zn AND DDT RESIDUES IN ALBACORE TUNA OFF OREGON IN 1969. Pearcy, William G.; Claeys, Robert R. (Oregon State Univ., Corvallis). Mar 1971. 26p. Dep. NTIS.

Albacore (Thunnus alalunga) is typically an oceanic tuna found far from continents. However, each summer a portion of the North Pacific population migrates into nearshore waters along the west coast of North America. Pearcy and Osterberg (1968) found that the zinc-65 radioactivity increased dramatically in albacore caught off Oregon and Washington during the summers of 1962–1966. This increase was attributed to the association of albacore with Columbia River water, a known source of radionuclides into these marine waters. Manigold and Schulze (1969) reported DDT, DDE and DDD in Columbia River water during various seasons, 1966 to 1968. Sometimes levels of residues were 0.1 ppb (1 $\mu g/l$), which is similar to those reported in the Sacramento River which drains agricultural lands where pesticides are heavily used. Therefore, if the Columbia River is a major mechanism for transport of DDT and its metabolites to the ocean, then DDT as well as ^{65}Zn should increase with time while albacore inhabit nearshore waters off Oregon during the summer. Similar trophic pathways and uptake rates for DDT and ^{65}Zn are implicit in this hypothesis. (auth)

23192 (UCLA-12-853) COMPARATIVE MYOCARDIAL DISTRIBUTION PATTERNS AFTER INTRACORONARY INJECTION OF CESIUM AND LABELED PARTICLES. Poe, Norman D. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1971]. Contract AT-04-1-GEN-12. 22p. Dep. NTIS.

To determine if soluble indicators could replace labeled macroaggregates for myocardial scanning after coronary artery injection, simultaneous coronary artery or left atrial injections of ^{131}Cs and several ^{99m}Tc labeled suspensions were made in dogs. Only very small particles (<35 μ) showed uniform distribution comparable to cesium. Perfusion defects and vascular beds were more discretely outlined with particles after atrial injection, but with arterial injection particle distribution determined by in vitro analysis often was markedly irregular. No significant differences were found in vivo. Ionic radiopharmaceuticals can be used as a safe substitute for macroaggregates for intracoronary administration. (auth)

23193 EFFECT OF COLLOIDAL IRON HYDROXIDE ON RADIOCERIUM METABOLISM IN RATS AND MICE. Pleskova, Anna; Trnovec, Tomas; Chorvat, Dusan; Vladar, Milan (Inst. of Industrial Hygiene and Occupational Diseases, Bratislava). Strahlentherapie; 142: No. 4, 480-5(Oct 1971).

The repeated application of Astrafer, a colloidal suspension of ferric hydroxide in complex with partially hydrolyzed dextrin, stimulated the reticuloendothelial system of rats and mice, but did not interfere with the kinetics of ^{131}I-rose bengal in the body. In mice with stimulated reticuloendothelial system the hepatic deposition of ^{144}Ce in both ionic and colloidal states decreased. In rats with stimulated reticuloendothelial system the kinetics of ^{144}Ce in blood and the pattern of the 24-hr organ deposition of ^{144}Ce were not affected through Astrafer application. Phagocytic competition observed between colloids characteristically taken up into Kupffer cells was not observed between Astrafer and ^{144}Ce. These experimental findings make questionable the role of Kupffer cells in initial stages of ^{144}Ce hepatic uptake in rats. Species differences between mice and rats in this respect remain open to further study. (auth)

23194 PHARMACEUTICAL STUDIES ON A ^{99m}Tc-COATED CARBON SUSPENSION INTENDED FOR DIAGNOSTIC PULMONARY SCANNING. El-Garhy, M.; Abdullah, E.; El-Bayoumy, E.; Madkour, M. K.; Sadeek, A. (Atomic Energy Establishment, Cairo Univ. Strahlentherapie; 142: No. 4, 463-6(Oct 1971).

Acute toxicity and histopathological studies were carried out on ^{99m}Tc-carbon suspension intended for diagnostic pulmonary scanning. The margin of safety of the carbon suspension as indicated by the ratio of the LD_{50} to the mean clinically useful dose would be so high as to exceed 1000. Histopathological tests in rabbits revealed the highly selective localization of carbon particles in lung tissues with no evident histopathological lesions. (auth)

23195 MILK TRANSFER COMPARISONS OF DIFFERENT CHEMICAL FORMS OF RADIOIODINE. Bretthauer, E. W.; Mullen, A. L.; Moghissi, A. A. (Western Environmental Research Lab., Las Vegas, Nev.). Health Phys.; 22: No. 3, 257-60(Mar 1972).

Lactating cows were orally dosed with I_2, CH_3I, NaI and $NaIO_3$ labeled with ^{131}I. For these 4 chemical forms, the effective half-life in milk was approximately one day for the first 5 days. The peak thyroid concentration occurred approximately 2.8 days after ingestion in all the cows. Ion-exchange analysis indicated that, regardless of the chemical form administered, 97% of the iodine in the milk was inorganic. These results suggest that in dairy cows there are no significant differences in the thyroid uptake and milk transfer among the compounds tested. (auth) (UK)

23196 GASTROINTESTINAL ABSORPTION, DISTRIBUTION, AND EXCRETION OF RADIOCESIUM. Stara, J. F. (Public Health Service, Cincinnati); Wolfangel, R. G.; Bruckner, B. H.; Moore, W. Jr. pp 265-76 of Intestinal Absorption of Metal Ions, Trace Elements, and Radionuclides. /Skoryna, S. C. (ed.). Elmsford, N. Y.; Pergamon Publishing Co. (1971).

The extent of the gastrointestinal absorption of cesium ions by mammalian species was estimated using several approaches: (1) From the cumulative urinary versus total excretion ratios; total absorption was estimated to be greater than 85% for monogastric animals and 40% to 60% for ruminants. Values in guinea pigs and rabbits fell into the intermediate range between the two major groups of animals. (2) From the sum of cumulative urinary excretion, milk secretion, and whole-body retention; the gastrointestinal absorption coefficient calculated by this method was greater than 90% for monogastric animals and at least 10% lower for the ruminants. The endogenous re-cycling process was not considered—for this reason, the results in both of the above approaches are underestimated. (3) Experimental values were assembled in which radiocesium was administered by various routes within the same species. Blood levels, the U/F ratio and tissue retention values appeared to be almost identical and independent of the route of isotope administration. It was concluded from these experiments that gastrointestinal absorption of ingested cesium experiments approaches 100% in all monogastric animals; however, according to the data available, ruminants do not conform. (4) In specific in vitro and in vivo studies with rats, the magnitude and anatomical sites of gastrointestinal absorption and secretion of cesium were reported. On the basis of these results, it appears that: (a) the absorption of radioactive cesium from the alimentary canal is efficient and essentially complete; (b) all intestinal segments tested had absorptive capacity, with the small intestine being most efficient, and the stomach and the cecum being least active; (c) the quantity of cesium excreted by the endogenous process approached 25% at 1 hr following an intravenous dose. The small intestine again acted as the major vehicle for this process; (d) the quantity and rate of absorption, as well as endogenous secretion progressively decreased along the alimentary tract from the duodenal toward the colonic segments. (auth)

23197 GASTROINTESTINAL ABSORPTION AND TISSUE RETENTION OF RADIORUTHENIUM. Stara, J. F.; Nelson, N. S.; Krieger, H. L.; Kahn, B. (Public Health Service, Cincinnati). pp 307-18 of Intestinal Absorption of Metal Ions, Trace Elements, and Radionuclides. /Skoryna, S. C. (ed.). Elmsford, N. Y.; Pergamon Publishing Co. (1971).

The chemical form or compound in which radioruthenium is administered influences the total amount absorbed. The absorption evidently occurs rapidly, high in the gastrointestinal tract since it was apparently complete within 2 to 6 hrs after the administration of the labeled compounds. The distribution of ruthenium in the organs of cats was similar to that observed in other species. After 5 days, kidney, bone, and testes, in that order, retained the highest proportion of the radioisotope. Whole-body retention of ^{106}Ru in cats has shown a long-term component with a half-life of 16 days over a period of 3 weeks; in other species in which retention data were collected for a longer period, and a third exponent was reported with a half-life of 7 weeks or more. The average urine/feces ratio in cats was 006 on the first day. After 7 days, the U/F ratio averaged 16 on a daily basis, indicating that absorbed ruthenium was excreted primarily via the kidney. The cumulative U/F ratio was used to estimate the amount of ruthenium absorption. This value did not take into consideration the proportion lost through the endogenous cycle and is therefore underestimated. Gastrointestinal absorption, turnover, and tissue retention of the five ^{106}Ru compounds suggest that a re-evaluation of the ICRP recommendations of the designation of the critical organ and the MPC should be made. (auth)

23198 TOXICITY IN THE DOG OF INHALED ^{90}Y IN FUSED CLAY PARTICLES: DISTRIBUTION, RETENTION KINETICS, AND DOSIMETRY. Barnes, J. E.; McClellan, R. O.; Hobbs, C. H.; Kanapilly, G. M. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Radiat. Res.; 49: No. 2, 416-29(Feb 1972).

The distribution, retention, and dosimetry of ^{90}Y inhaled in a relatively insoluble form, fused clay, were studied. Twelve beagles were exposed to an ^{90}Y fused clay aerosol with an activity median aerodynamic diameter of 1.4–1.6 μm, and then killed in pairs at 1 hour and 2, 4, 6, 8, and 12 days postexposure. After clearance of the upper respiratory tract, ^{90}Y was found predominantly in the lung. The concentration of ^{90}Y in the tracheobronchial lymph nodes approached that in the lung by 12 days postexposure. Infinite radiation doses to the lung, tracheobronchial lymph nodes, skeleton, and liver were estimated to be 1200, 170, 0.54, and 0.38 rads per mCi initial lung burden, respectively. Infinite radiation doses to the blood circulating through the lung and the rib bone marrow from ^{90}Y in the lungs were estimated to be 120 and 290 rads per mCi initial lung burden, respectively. Activity deposited in the upper respiratory tract was cleared via the gastrointestinal tract and resulted in an estimated dose to the colon of 180 rads per mCi. ^{90}Y inhaled in this relatively insoluble fused clay form was found well suited for the study of biological effects of a high dose-rate energetic beta emitter in the lung. (auth)

23199 INTRAVITAL MEASUREMENT OF γ-RAY EMITTERS IN MARINE HYDROBIONTS. Belyaeva, O. I.; Freiman, G. A.; Bachurin, A. A. (Inst. of Biology of Southern Seas, Kiev). Ecology (USSR) (Engl. Transl.); No. 4, 358-60(Jul-Aug 1970).

Translated from Ekologiya; No. 4, 103-5(Jul-Aug 1970).

A method is described for determination of the concentration factors of living hydrobionts for gamma-active isotopes. A counter composed of a specially constructed gamma detector and standard radiometric equipment was used. The scintillation γ-ray detector was cut from a block of plastic scintillator (solid solution of p-terphenyl in polystyrene). It was 76 mm in diameter and 145 mm high. The scintillator had a well 38 mm in diameter and 126 mm deep. The detector was mounted in a light-tight case with a diffusing layer of magnesium oxide. The photomultiplier operating conditions, the discrimination level, and the minimum time of measurement were chosen to secure the best signal/noise ratio with a prescribed statistical error. For reduction of the external background the entire detector was accommodated in a shield made from alloy steel produced before the start of atomic explosions in the atmosphere. The wall thickness was 7.5 cm. The method was used to measure the uptake of cesium-137 by ten specimens of Leander squilla (Black Sea prawns). The calculated minimum necessary volume of water for this experiment was 230 ml per specimen. The advantage of the method lies not only in the possibility of following the uptake of radionuclides by one biological unit over a long period of time, but also in the number of animals (only 10 to 12) required for the whole experiment. (auth)

23200 ABSORPTION AND RETENTION OF ^{144}Ce AND ^{95}Zr–^{95}Nb IN NEWBORN, JUVENILE, AND ADULT RATS. Shiraishi, Yoshiyuki; Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 22: No. 4, 373-8(Apr 1972).

The effect of age on the absorption and retention of ^{144}Ce and ^{95}Zr–^{95}Nb in rats was investigated with special emphasis on sucklings. Although poorly absorbed by adult rats, these nuclides were absorbed to a considerable extent by suckling rats, resulting in a 10 to 1000 times higher retention than in adults. The initial rapid loss of the nuclides from suckling rats disappeared at around weaning age and was followed by a considerably slower exponential decrease. Though the adult rats showed a much steeper and larger initial loss, a similar rate of exponential decrease was observed thereafter. The whole-body retention curves for suckling rats previously treated with cortisone acetate showed much steeper initial loss and significantly lower retention than those for controls. The ratio of ^{95}Zr–^{95}Nb in bone of sucklings was found to be approximately 4 to 5, whereas that in most of their soft tissues was almost unity. It was suggested that the substantial absorption of these nuclides by suckling rats was mainly due to the pinocytosis being more active in younger animals. (auth)

23201 BILIARY PLUTONIUM EXCRETION IN THE RAT. Ballou, J. E.; Hess, Joan O. (Battelle-Northwest, Richland, Wash.). Health Phys.; 22: No. 4, 369-72(Apr 1972).

About 50% of the plutonium excreted into the perfused intestine of the rat during the first hour after plutonium injection arrived by way of the bile. After DTPA treatment, the proportion excreted in bile was increased to 75% and the bile plutonium concentration increased 15 to 20 fold. The prompt appearance of plutonium in the bile after injection suggested that the transfer from blood to bile of at least a portion of the plutonium occurred by a relatively direct process. (auth)

23202 INCORPORATION OF ^{67}Ga IN NORMAL AND MALIGNANT CELLS AND ITS DEPENDENCE ON GROWTH RATE. Bichel, P.; Hansen, H. Hvid (Cancer Research Inst., Aarhus, Denmark). Brit. J. Radiol.; 15: No. 531, 182-4(Mar 1972).

The cellular incorporation of ^{67}Ga was investigated in a murine ascites tumor and in normal bone marrow cells from mice. In both tissues a high proliferation rate corresponded to a high incorporation of ^{67}Ga, and it is suggested that the concentration of ^{67}Ga in the cells, malignant or nonmalignant, is related to, or possibly dependent on, the rate of cellular proliferation in the tissue. (auth)

Plants

23203 (RLO–2227-T-12-9) NON-BIOLOGICAL UPTAKE OF ^{65}Zn FROM A MARINE ALGAL NUTRIENT MEDIUM. Tomlinson, Richard D.; Renfro, William C. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. 21p. Dep. NTIS.

The nature and magnitude of experimental errors due to ^{65}Zn adsorption on inorganic surfaces were examined in a laboratory system designed to measure ^{65}Zn uptake by marine phytoplankton. In the pH range, 6.3 to 7.5, a precipitate formed in the algal nutrient medium and accumulated up to 70% of the ^{65}Zn in the medium within 24 hours. It was concluded that ^{65}Zn adsorption by undetected precipitates could result in serious errors in measurements of ^{65}Zn uptake by marine phytoplankton. The relationship between the percent adsorption of ^{65}Zn in the contained sample and wetted glass surface area/pipette sample volume was shown to be linear for volumetric pipettes of 1 to 15 ml. At a pH value of 8.0, glassware with surface area/sample volume ratios as small as those of 20 ml volumetric pipettes adsorbed 7 to 11% of the contained sample activity. Use of polypropylene apparatus reduced zinc adsorption during experimental transfers. (auth)

23204 EFFECTS OF SOIL FACTORS ON THE UPTAKE OF RADIOSTRONTIUM BY PLANTS. PART III. Paasikallio, Arja; Haekkinen, Ulla; Lakanen, Esko (Agricultural Research Center, Tikkurila, Finland). Ann. Agr. Fenn., Ser. Agrogeol., -Chim. -Phys.; 10: No. 3, 125-30(1971).

The proportional uptake of ^{89}Sr in relation to Ca by plants growing in different types of peat soils was found to decrease with increasing degree of decomposition, i.e., with decreasing C/N ratio, and with increasing humic acid content and CEC (meq/l) of the growth medium. Increasing amounts of various fractions of organic matter (humin and humic acids) mixed with a fine sand decreased the uptake of radiostrontium and calcium by plants. However, the ^{89}Sr/Ca ratio of the plants increased when the organic matter content of the soil was low. (auth)

New Tracer Techniques

23205 RADIOIMMUNOCHEMICAL STUDIES ON NUCLEOSIDE-SPECIFIC ANTIBODIES USING IODINATED DNA. Rosenberg, Burton J.; Erlanger, Bernard F.; Beiser, Sam M. (Columbia Univ., New York). J. Immunol.; 108: No. 1, 271-4(Jan 1972).

The feasibility of utilizing DNA labeled in vitro with ^{125}I for radioimmunochemical studies on antinucleoside antisera was studied. The labeled DNA retained its ability to react with antisera specific for adenosine, cytidine, guanosine, or uridine. The procedure for preparing iodinated DNA is described. Rabbits were immunized with bovine serum albumin conjugates of adenosine, cytidine, guanosine, and uridine. The binding of antibody with IDNA was measured by the double antibody technique. The results demonstrated immunochemical specificity of the labeled DNA and also showed that iodination has the advantage over other in vitro labeling procedures of higher specific activities and gamma emission. (H.L.W.)

23206 RADIOMETRIC MICROMETHOD FOR QUANTITATION OF GLUCOSE UTILIZATION BY THE ERYTHROCYTE. Hutton, John J. (Roche Inst. of Molecular Biology, Nutley, N. J.). Anal. Biochem.; 45: No. 2, 577-84(Feb 1972).

Tritiated water is formed when 2-^{3}H-glucose-6-phosphate is isomerized to fructose-6-phosphate by glucosephosphate isomerase. This isomerization is the first reaction unique to glycolysis. The maximum rate of glycolysis can be estimated by measuring the rate of formation of tritiated water by erythrocytes incubated in the presence of glucose-2-^{3}H. The procedure is extremely sensitive and requires very few cells to obtain reliable results. The method

may be useful in estimating the rate of glycolysis in other cell types, but it is not reliable if a large fraction of the glucose is metabolized via the hexose monophosphate shunt or if there is a metabolic block preventing the conversion of fructose-6-phosphate to lactate. (auth)

23207 RADIOIMMUNOASSAY OF TESTOSTERONE WITHOUT CHROMATOGRAPHY. Ismail, Adel A. A.; Niswender, Gordon D.; Midgley, A. Rees Jr. (Univ. of Michigan, Ann Arbor). J. Clin. Endocrinol. Metab.; 34: No. 1, 177-84(Jan 1972).

A globulin fraction rich in bound testosterone was separated from serum by ammonium sulfate precipitation. Testosterone and related steroids were quantitatively extracted from this fraction with a benzene petroleum ether mixture and measured by radioimmunoassay using testosterone-3-tyrosine methyl ester-^{125}I and a specific antiserum elicited against testosterone-3-oxime bovine serum albumin. This assay procedure, which avoids chromatography and uses only one organic solvent extraction had blank values that approached zero. The within and between assay error, measured as the coefficient of variation was 7.8% (n = 64) and 8.2% (n = 15), respectively. The minimum amount of hormone per sample that can be measured with good reliability is 0.17 ng. This provides sufficient hormone to account for losses during the procedure, and to allow quadruplicate samples for radioimmunoassay and an aliquot for determining recovery. Although introduction of an additional thin layer chromatographic step was associated with results that were approximately 10% lower than those obtained without chromatography, these differences were not statistically significant. An excellent agreement was found between the amount of unlabeled hormone added to male, female, or pregnancy serum and the amount measured by the present technique. The mean testosterone concentration (±SD) in nine normal men, six normal cycling women, and four pregnant women (third trimester) was 5.96 ± 2.02; 0.46 ± 0.21, and 0.97 ± 0.24 ng/ml respectively. The method is simple and practicable; one technician can easily complete 300 assays in five working days. (auth)

23208 PROCEEDINGS OF THE TEL AVIV UNIVERSITY CONFERENCE ON ERYTHROPOIESIS, TEL AVIV, ISRAEL, JULY 27-29, 1970. Israel J. Med. Sci.; 7: No. 7-8, 820-1028 (Jul-Aug 1971). (CONF-700723).

A separate abstract was prepared for one of the 29 papers presented in the conference. The other papers discuss: fetal and neonatal erythropoiesis; assay of erythropoietin; androgens and erythropoiesis; mechanism of action of erythropoietin; production of erythropoietin (renal and extrarenal sources); and inhibitors of erythropoietin. (E.R.B.)

For abstract of an individual paper see: 23209.

23209 RADIOIMMUNOASSAY FOR HUMAN URINARY ERYTHROPOIETIN. Fisher, James W.; Thompson, J. F.; Espada, J. (Tulane Univ., New Orleans). Israel J. Med. Sci.; 7: No. 7-8, 873-6(Jul-Aug 1971).

From Conference on erythropoiesis; Tel Aviv, Israel (27 Jul 1970).

A radioimmunoassay for human urinary erythropoietin (ESF) using ^{125}I-labeled purified human ESF is described. This assay appears to be sensitive enough to detect quantities of erythropoietin as low as 25 ng or 0.045 m units. With the use of this radioimmunoassay technique the 24-hr urinary excretion of erythropoietin in three normal human subjects was found to be between 4.93 and 30 mg, whereas, the 24-hr urinary excretion of ESF in four anemic patients ranged between 72.5 and 303 mg. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 22662, 22936, 23301, 23325, 23347, 23355, 23367, 24683, 24688, 24694, and 24702.

23210 (BMBW-FBK-71-18) INVESTIGATION OF REACTOR FUEL MATERIALS AT HIGH TEMPERATURES (DIFFUSION, PHASE RELATIONSHIPS, DRY REPROCESSING PROCEDURES). Lindner, R. (Technische Universitaet, Brunswick (West Germany). Institut fuer Kern- und Radiochemie. European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec 1971. 28p. (In German). Dep. NTIS (U. S. Sales Only).

Measurements of actinide diffusion coefficients in uranium carbide and platinum are reported. In platinum which was chosen as a "standard matrix" very exact values of the diffusion parameters can be obtained. Therefore, small, but significant differences between the diffusion activation energies of neighboring actinide elements could be detected which are in accordance with current theories. In uranium carbide these small differences are within the limits of error of the experimental determination. Results of further measurements confirm the strong dependence of activation energies of diffusion on the chemical composition of this material. Determinations of protactinium solubility in α-thorium metal have been completed. As a final result the following solubilities were found: 6.7 ± 0.3% at 1300°C and 4.5 ± 0.5% at room temperature. In the pseudobinary phase diagram UC/UO under certain conditions mixed phases extending over the whole range of concentrations could be observed for the first time. Their lattice parameters are following Vegard's law. Basic studies aiming at the development of a salt transport process for reprocessing thorium bearing nuclear fuels have been continued. Special regard was given to the determination of thorium distribution coefficients between an eutectic chloride melt and different magnesium alloys as a function of Mg-concentration. (auth)

23211 (CEA-R-4228) SELF DIFFUSION OF OXYGEN IN URANIUM DIOXIDE. Contamin, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec 1971. 90p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Universite Scientifique et Medicale de Grenoble, France.

The self-diffusion of oxygen in stoichiometric and hyperstoichiometric uranium dioxide was investigated between 650 and 1250°C (UO_2), and 400 and 900°C (UO_{2+x}) $0,005 \leq x \leq 0,16$. The ^{18}O diffusion profiles were determined using various methods for the analysis of the isotopic composition of the surface: mass spectrometry (spark, laser, or secondary ion emission) or the nuclear reaction $^{18}O(p,\alpha)^{15}N$. The activation energy for the self-diffusion of ^{18}O is 59 kcal $mole^{-1}$ for stoichiometric UO_2 and 21 kca' $mole^{-1}$ for UO_{2+x}. The apparent diffusion coefficient is reduced when a second phase U_4O_9 is present in UO_{2+x}. No grain boundary diffusion of oxygen was evidenced. The self diffusion of oxygen in UO_{2+x} may be expressed as a function of x (x > o) and T in a semi empirical equation. (auth)

23212 (GEAP-12254) A THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 17, August 1, 1971–October 31, 1971. Aitken, E. A.; Adamson, M. G.; Evans, S. K.; Ludlow, T. E. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Oct 1971. Contract AT(04-3)-189. 16p. Dep. NTIS.

Work progress is reported in the continuing scope of work related to thermodynamics of sodium-fuel reactions, and oxygen redistribution in a temperature gradient, with and without excess sodium. (auth)

23213 (GEAP-13637) STEADY STATE AND DEFECTED FUEL IRRADIATION TESTING NEEDS. Meinhardt, W. G. (comp.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Sep 1970. Contract AT(04-3)-189. 129p. Dep. NTIS.

Research directed toward the development of LMFBR fuels and programs needed in these efforts are described. Information is included on economic considerations, UO_2-PuO_2 fast flux irradiations, extrapolation of irradiation results, results of defected pin testing, fuel testing for safety and licensing, fuel pin performance testing needs, fuel bundle testing, and test recommendations. (J.R.D.)

23214 (KFK-1239) CONSTRUCTION, IRRADIATION, AND CHECK ON UO_2 FUEL PINS IN THE FR 2 CAPSULE GROUP 3. Geithoff, D.; Freund, D.; Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Aug 1971. 128p. (In German). Dep. NTIS (U. S. Sales Only).

In Capsule Group No. 3 irradiation experiment, 34 fuel pins were irradiated in a thermal flux in the FR 2-Reactor. The pins contained UO_2-pellets or vibrocompacted UO_2-particles as fuel with stainless steel cladding. In some specimens, CeO_2 had been added for chemical simulation of PuO_2. At rod powers up to 700 W/cm and cladding temperatures around 600°C burnups up to 85 MWd/kg metal were achieved. Postirradiation examination of the pins showed the typical restructuring of the fuel (formation of central voids, radial cracks) while there were no visible effects on the cladding. This report is a documentation in which all details on subjects such as aim of the experiment, pin design and specification, preparation of the specimens, pre-irradiation testing, irradiation history, and nondestructive and destructive postirradiation examination are given. (auth)

23215 (ORO-4212-10) QUANTITATIVE DETERMINATION OF THE STRUCTURE–PROPERTY RELATIONSHIPS IN NUCLEAR FUEL ELEMENT MATERIALS. Quarterly Progress Report, September 16–December 15, 1971. Rhines, F. N.; DeHoff, R. T.; Whitney, E. D. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Feb 1972. Contract AT-(40-1)-4212. 39p. Dep. NTIS.

Analysis of permeability data for porous nickel sinterings resulted in the equation: $K_\infty = 0.136\ [V_V(V_V - 0.08)]^{1.2}\bar{\chi}^{1.3}$ where V_V is the volume fraction of porosity and $\bar{\chi}$ is the mean pore intercept. The equation can be used in predicting the permeability over the full range of structures examined with an accuracy of 7%. Tensile strength of porous nickel sinterings is found to obey the relation $\sigma/\sigma_0 = P^2$ where σ/σ_0 is a normalized tensile stress, and P is a normalized porosity parameter. This equation can be used to predict strength with an accuracy of about 25%. Additional tensile test results are reported and correlated with quantitative microscopy of fracture surfaces. Creep studies of nickel sinterings have been extended to a broader range of test conditions, and the effect of creep on microstructure has been quantitatively assessed. Permeability testing of porous UO_2 sinterings has been extended to a broader range of structural conditions. (auth)

23216 (RCN-158) PROGRESS REPORT OF THE MATERIALS DEPARTMENT, SECOND QUARTER 1971. Blackstone, R. (ed.) (Reactor Centrum Nederland, Petten). Nov 1971. 57p. Dep. NTIS (U. S. Sales Only).

A description is given of the progress in the various projects concerning the materials development of water-cooled reactors, sodium-cooled fast reactors, and gas-cooled reactors. (auth)

23217 (RD/B/N-2116) AN ASSESSMENT OF THE METHODS AVAILABLE FOR MEASURING SCALE-METAL ADHESION AND THE MECHANICAL PROPERTIES OF OXIDES. Wootton, M. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1971. 17p. Dep. NTIS (U. S. Sales Only).

Various methods of measuring scale–metal adhesion and the mechanical properties of oxides are discussed. Of these, only one permits the assessment of both parameters, and is also capable of measuring the mechanical properties of as-growing oxide. This method is based on measurement of the change in frequency of vibration of an oxidizing rod. (UK)

23218 (RFP-1702) SPUTTER COATING OF TITANIUM CARBIDE ON CUTTING TOOLS. Mah, George; Wright, Robert J.; Chapin, John S.; Fuller, John E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 18 Feb 1972. Contract AT(29-1)-1106. 9p. Dep. NTIS.

Titanium-carbide coated tools by chemical vapor deposition are commercially available. The coating improves the cutting properties and helps to provide longer wear of tools. However, undesirable factors are evident in the chemical vapor deposition process. A sputtering process has been developed for coating tungsten carbide cutting tools with titanium carbide. The x-ray diffraction results indicate that the coating has the same stoichiometric composition as the target, and the coating has a (111) preferred orientation. Photomicrographs show the coating to be of fine-grain structure. The coating has hardness values of 2400 kg/mm^2 which are in agreement with the values of bulk titanium carbide. Evaluations of coated tools versus uncoated tools showed that the coating increases the effective life of the tool, reduces the tool force, and improves the surface finish. Such improvements from coated tools should increase the quality of products and result in cost savings. (auth)

23219 (WARD-4210-T-3-10) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1971. Anderson, C. A. Jr.; Bishop, E. C.; Boltax, A.; Ray, W. E. (Westinghouse Electric Corp., Madison, Pa.

Advanced Reactors Div.). Oct 1971. Contract AT(30-1)-4210. 131p. Dep. NTIS.

Results of analytical and experimental studies on mixed oxide fuel pins are reported. Data and information are included on radiation testing of mixed oxide fuel pins, post-irradiation inspection of fast reactor fuels, development of EBR-II grid-type subassemblies, machine tool development for fuel fabrication, fuel pellet fabrication, oxide fuel characterization, fuel pin fabrication, grid-type fuel assembly development, development of LMFBR fuel assemblies, development of fuel analytical methods, and evaluation of cladding irradiation behavior. (J.R.D.)

23220 (Y-1819) SLIP CASTING OF ZIRCONIUM DIBORIDE. Holcombe, C. E. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 28 Feb 1972. Contract W-7405-eng-26. 17p. Dep. NTIS.

The slip casting of zirconium diboride (ZrB_2) shapes was studied. The best slip casting properties were obtained with 3% sodium carboxymethylcellulose (CMC) solution as the liquid phase along with powder that had been ball milled for one week. The stability of the slip, casting rates, and flow properties were investigated. Various shapes were slip cast, indicating the capability of the method to produce complex shapes, both large and small. Both drain casting and solid casting were employed. A brief investigation established the feasibility of slip casting (with a 3% CMC solution as the liquid phase) hafnium diboride, pure boron, boron carbide, chromium diboride, and a zirconium diboride–10% tungsten cermet. (auth)

23221 REACTION OF LIQUID STEEL WITH DIBORIDES OF REFRACTORY METALS. Kuzenkova, M. A.; Kislyi, P. S.; Goncharenko, G. N. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 720-3 (Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 50-3(Sep 1971).

Studies were made on the reactions of liquid steel with Ti and Zr diborides during prolonged contact. During the reaction of ZrB_2 with liquid steel, a compound having a dark-gray color and a microhardness of 950 ± 50 kg/mm^2 was formed on the surface of the diboride. It was assumed that the dark-gray transition layer consisted chiefly of ZrO_2. The mechanism of formation of the dark-gray compound is discussed. Similar results were found with TiB_2. However, with TiB_2 the layer consisted of a loose, weak oxide and afforded no protection against further oxidation, as a result of which TiB_2 rapidly disintegrated in liquid steel. Thus, ZrB_2 is recommended as a highly refractory material capable of withstanding attack by molten steel and may be used in continuous metallurgical installations. (P.C.H.)

23222 GAS-POWDER DEPOSITION OF BORON CARBIDE. Shutov, I. D.; Dobrovol'skii, A. G. (Kiev Engineering and Construction Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 705-8(Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 30-4(Sep 1971).

The possibility of producing wear-resistant coatings on parts by the technique of gas-powder deposition of boron carbide has been demonstrated. The structure of the deposited layer contains no free boron carbide particles and consists of a eutectic and a dendritic zone; boron carbide particles cover only the surface of the layer. The wear resistance of alloys produced by the deposition of boron carbide and mechanical mixtures of the carbide and iron powder on a steel substrate is approximately the same, but is higher than that of boron carbide coatings on nickel-containing alloys. (auth)

23223 COLOR PROBLEM OF TUNGSTEN TRIOXIDE. X-RAY STUDIES. Farag, M. S.; Hanafi, Z.; Khilla, M. A. (National Research Center, Cairo). Z. Phys. Chem. (Frankfurt); 76: No. 5-6, 265-72(Dec 1971).

X-ray diffraction analysis of 8 samples of tungsten trioxide prepared by ignition at temperatures in the range of 380 to 1100°C proved that they all belong to the nonstoichiometric form of WO_3 with traces of $WO_{2.92}$ in the green samples. Peak profile analysis of the diffraction lines showed that the particle size and the micro-strain obey a Cauchy distribution. The variations of these 2 quantities as well as color with temperature are given. A comparison between the relative variation of density and that of the unit cell dimensions showed that Schottky defects are prevailing and are greater in the green sample. The missing atoms are mainly the oxygen ions whose number reaches a minimum in samples prepared in the range 750 to 800°C. (auth)

23224 POROSITY OF PLASMA-SPRAYED COATINGS. Chevela, O. B.; Morozov, I. A.; Loginov, V. E.; Dmitrieva, E. V. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 732-7(Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 65-71(Sep 1971).

Studies were made on the porosity of plasma-sprayed W and ZrO_2 coatings with and without substrates. Formulas for determining the porosity of coatings on substrates and of coatings detached from the substrates are given. A study on the effects of range in the spraying of W onto various substrate materials demonstrated that with increase in range, the open porosity of the coating varied nonmonotonically, whereas the total porosity generally increased. However, raising the arc current intensity reduced porosity. It was also found that the porosity of a sprayed coating depended to a large extent on the nature of the substrate material. In the spraying of stabilized ZrO_2 onto OT-4 Ti alloy, coating porosity was found to fall with increase in spraying range. With increasing arc current intensity, the porosity decreased, particularly at ranges of 110 and 170 mm. Increasing the rate of argon flow from 25 to 40 l/min reduced the porosity, because in this case the heat content grew while the temperature fell only very slightly. (P.C.H.)

23225 THERMAL DISSOCIATION OF MOLYBDENUM, TUNGSTEN, AND NIOBIUM DISULFIDES AND DISELENIDES AND BORON NITRIDE IN HELIUM. Sychev, V. V.; Yurchenko, D. Z.; Tkachenko, Yu. G.; Obolonchik, V. A.; Drozdova, S. V. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 744-7(Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 80-4(Sep 1971).

A study was made of the thermal stability of tungsten and molybdenum disulfides, molybdenum, tungsten, and niobium diselenides, and boron nitride at temperatures of 1050 to 1350°C. It was established that, in the temperature range 1000 to 1250°C, tungsten and molybdenum disulfides are thermally stable in a helium atmosphere under an excess pressure of 0.2 atm gauge. It was demonstrated that molybdenum diselenide is stable during isothermal holding in helium for 10 h at temperatures up to 1150°C, while niobium diselenide forms homogeneous phases during 2.5-h holdings in the range 1000 to 1250°C and 1-h holdings at 1350°C. It was also established that boron nitride exhibits no changes during holding in a helium atmosphere for up to 35 h in the temperature range 1050 to 1350°C. (auth)

23226 CERAMIC-FUELS COMPRESSIVE-CREEP RIG. Stratton, R. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Nucl. Eng. Int.; 17: No. 189, 100-3(Feb 1972).

Descriptions are given of the specification, production, and some details of the performance of a Harwell compressive-creep rig for studying the creep behavior of uranium dioxide under irradiation at 750°C. The scientific requirements are outlined and the solutions to some of the design problems arising out of creep measurement in a reactor environment are given. A description of the rig and its performance over seven cycles of reactor operation is included, together with a preliminary creep curve. (auth)

23227 APPARATUS FOR COATING MICROSPHERES WITH PYROLYTIC CARBON. McCreary, William J.; Court, Donald B. (to United States Atomic Energy Commission). U. S. Patent 3,636,923. 25 Jan 1972. Filed 4 Mar 1970.

A fluidized bed coater capable of depositing uniform coatings of high-density, oriented pyrolytic carbon having a smooth microstructure on a charge of particles having an initial surface area of 44,000 cm^2 is described. The deposition is accomplished from an atmosphere containing methane and an inert gas at a temperature of about 1,200°C. (Official Gazette)

23228 STABILIZED ZIRCONIUM DIOXIDE AND HAFNIUM DIOXIDE COMPOSITIONS. Fehrenbacher, Larry L. U. S. Patent 3,634,113. 11 Jan 1972. Filed 30 Oct 1968.

A Type C mixed rare earth oxide solid solution is used to eliminate the monoclinic phase of zirconium dioxide and thus produce a stable refractory. The Type C solid solution consists primarily of oxides of dysprosium, erbium, ytterbium, and holmium with small amounts of thulium, terbium, and lutetium. This solid solution is applicable to hafnium dioxide and to mixtures of hafnium dioxide with zirconium dioxide as well. (Official Gazette)

23229 PREPARATION OF BORON SUBOXIDE, B_6O. Holcombe, C. E. Jr.; Horne, O. J. Jr. (Union Carbide Corp., Oak Ridge, Tenn.). Contract W-7405-eng-26. J. Amer. Ceram. Soc.; 55: No. 2, 106(Feb 1972).

A simple method for preparing the refractory suboxide of boron (B_6O) is described. The method consists of heating B and ZnO for 4 h at 1200 to 1550°C according to the reaction $ZnO + 7B \xrightarrow{heat} B_6O + Zn$. The presence of suboxide was confirmed by x-ray diffraction analysis, which revealed only B_6O. This method eliminates both the formation of the B_2O_3 molten phase and Zn–B compounds. The Zn is salvaged by collecting it in a bubbler. (P.C.H.)

23230 DECOMPOSITION TEMPERATURE OF $Th(WO_4)_2$. De Maayer, P.; De Bruyne, R.; Brabers, M. J. (Catholic Univ., Louvain, Belgium). J. Amer. Ceram. Soc; 55: No. 2, 113(Feb 1972).

The peritectic decomposition temperature of $Th(WO_4)_2$ was determined by thermal analysis to be 1640 ± 15°C on the average. The specimen was heated to 1580°C and allowed to equilibrate. The temperature was then raised slowly to 1700°C, held for 10 min, and decreased to 1580°C by setting the power on the initial value; this sequence was repeated twice. No change in color or x-ray diffraction pattern was noted after this treatment; only a small weight loss resulting from evaporation was detected. (P.C.H.)

23231 DIFFUSION DATA, VOLUME 5, NO. 4, 1971. Woehlbier, F. H. (ed.). Diffus. Data; No. 4, 585-734(1971).

Diffusion data on solid metals and alloys, liquid metals and alloys, semiconductor, oxides, halides, boron, carbides, hydrides, thiocyanates, silicides, and nitrites and nitrates are given. 125 references to articles on diffusion in these materials are included, along with other references of interest in the field of solid state diffusion, which are not covered in the data sections. Separate indexes are included for author, host substance, and phenomenological topic. (P.C.H.)

23232 PREPARATION OF CONDENSED ScO. Work, Dale E.; Eick, Harry A. (Michigan State Univ., East Lansing). J. Less-Common Metals; 26: No. 3, 413-16(Mar 1972).

Studies were made on the thermodynamic feasibility of the reaction $Sc_2O_3(s) + Si(l) = 2ScO(s) + SiO(g)$, and the data cited by Dufek et al. (Monatsh. Chem., 100, p. 1628, (1969)) were reexamined as evidence for the existence of ScO under the specified conditions. The results showed that the reported preparation of condensed ScO, with Sc in the divalent state, is thermodynamically untenable. It was concluded that an oxide–nitride reaction product now appears to be a reasonable hypothesis. (P.C.H.)

23233 DISSOLUTION BEHAVIOR OF CARBIDES IN AQUEOUS ENVIRONMENTS. Payer, Joe Howard. Columbus, Ohio; Ohio State Univ. (1971). 242p. University Microfilms Order No. 72-4607.

Thesis.

The dissolution behavior of carbides in aqueous environments was investigated. A series of Fe–C alloys was prepared containing 0.8, 2.0, and 4.3 weight percent carbon. The effect of the amount of cementite present on the dissolution behavior of the alloys was determined in pH 2, 4, and 6 H_2SO_4. The carbon products of carbide dissolution were determined as a function of potentials by gas chromatography. The polarization behavior of titanium carbide, vanadium carbide, chromium carbide, thorium carbide, and uranium carbide in pH 1, 3, and 5 H_2SO_4; pH 1 HCl; and 1N NaOH is described. Additional experiments were performed with the carbides to answer specific questions concerning the dissolution behavior. The dissolution of the Fe–C alloys was investigated to gain a better understanding of the behavior of iron carbide, which could not be obtained in a pure form suitable for electrochemical studies. To aid in the rationalization of the carbide behavior the potential pH diagrams of Fe_3C, $Cr_{23}C_6$, and Cr_7C_3 were calculated. These diagrams define the regions of stability of the thermodynamically stable species for the carbide-water systems at 25°C. It was found that the alloys have an increased tendency to passivate as the carbide content increases; this is reflected in the decrease of the maximum anodic current with increasing carbide content. The passive current increases as the carbide content increases. This effect is only observed in pH 2 H_2SO_4. The corrosion potential becomes more noble as the carbide content increases. The reduction kinetics increase with increasing carbide content. This is most noticeable in pH 2 H_2SO_4. Fe and Fe–C alloys exhibit complex cathodic polarization curves, whose shapes are pH dependent. The carbon dissolution products are a function of the potential at which dissolution occurs, with hydrocarbons being evolved at active potentials and carbon oxides at noble potentials. The prevalent notion among many metallurgists that carbides are inert to attack and behave like graphite in aqueous solutions is not valid. TiC, VC, $Cr_{23}C_6$, ThC, UC dissolve by an electrochemical process. The dissolution behavior of these carbides is closely related to that of the metal constituent of the carbide. The kinetics of the hydrogen reduction reaction vary considerably on the different carbide substrates, but are of the same order of magnitude as those observed on transition metals. Opposite pH dependence of the passive current is observed for titanium carbide and uranium carbide. The complex cathodic polarization curves for film covered carbides can be rationalized in terms of the reduction of the film during polarization. The dissolution kinetics increase with increasing temperature. The increase in current with increasing potential for film covered carbides is a transient process. Chloride has no appreciable effect on the anodic polarization behavior of titanium carbide, vanadium carbide, or chromium carbide, but increases the dissolution rate of uranium carbide substantially. (Diss. Abstr. Int., B)

23234 CARRIER FOR URANIUM OXIDE PELLETS. Rode, James A.; Hubert, Paul W. (to United Nuclear Corp.). U. S. Patent 3,632,095. 4 Jan 1972. Filed 4 Oct 1968.

A carrier of uranium oxide pellets is described which is suitable for use in dewaxing and sintering of the pellets. The carrier has a molybdenum or stainless steel base on which there are multiple layers of corrugated molybdenum sheets for holding the pellets within the depressions of the parallel corrugations. The molybdenum sheets are placed above each other with the corrugations running in about the same general direction. The separation of these sheets is by the uranium oxide pellets during the sintering operation and by molybdenum cylinders of a larger diameter than the pellets during the dewaxing operation. (Official Gazette)

23235 STUDY OF ZIRCONIUM DIOXIDE WHITE PIGMENT FOR SPACE ENVIRONMENT. Kan, H. K. Alan; Champetier, R. J.; Erler, T. G. (Aerospace Corp., El Segundo, Calif.). J. Spacecraft Rockets; 9: No. 2, 103-6(Feb 1972).

The properties of zirconium dioxide as a stable white pigment (low α/ϵ) for space application are investigated. A study of the optical absorption of single crystals indicates that a high degree of purity, except for hafnium, is essential for low α/ϵ applications. A pigment preparation study and irradiation experiments with uv and 3-keV protons are described. The experimental ZrO_2 coatings initially have solar absorption $\alpha \leq 0.11$ and thermal emittance $\epsilon = 0.9$. Over-all radiation stability (uv and proton) is shown to be binder dependent, with potassium silicate more stable than silicones. Potassium silicate coatings show $\Delta\alpha = 0.06$ after 2400 uv equivalent solar hours, and $\Delta\alpha = 0.01$ after irradiation with 3-keV H^+ and H_2^+ to a fluence of 10^{16} particles/cm^2. (auth)

23236 INFLUENCE OF DIFFERENT DIAMOND POLISHING PASTES ON THE POLISHED SURFACE QUALITY OF CERMETS. Spieler, Klaus (Kernforschungszentrum, Karlsruhe, Ger.). Prakt. Metallog.; 9: No. 1, 27-31(Jan 1972). (In English and German).

It was demonstrated that the same metallographically polished surface quality is produced using a special diamond paste in a shorter time (40 min) than with the normal pastes (100 min). This result was obtained from quantitative measurements on UO_2-steel cermets. Specimen preparation and quantitative determination of the polished surface quality are described. The results of the comparison are illustrated graphically. (auth)

23237 CORRELATION BETWEEN THE IMPACT STRENGTH AND THERMAL EXPANSION OF CAST REFRACTORY BLOCKS. Romwalter, A.; Vassel, K. R.; Gurubi, L. (Research Inst. for Non-Ferrous Metals, Budapest). pp 131-9 of Proceedings of the Research Institute for Non-Ferrous Metals. Budapest; Akademiai Kiado (1971).

From Proceedings of the Research Institute for Non-Ferrous Metals; Budapest, Hungary (May 1968). See CONF-680568.

The production of cast refractory blocks is discussed. From the experiences cited, it was concluded that the basic condition for the production of high-impact strength cast blocks is a sufficiently slow cooling technology, which includes temperature differences likely to cause dangerous stresses. Since the components of some cast refractory blocks include compounds that undergo transformation into other modifications, such as zirconia, and since the thermal expansion of these substances changes abruptly and vary considerably in the temperature zone of transformation, it is not always technologically possible to reduce the cooling rate to the required level. In such cases the abrupt change of thermal expansion due to transformation may be reduced to the desired level by a suitable selection of the chemical composition of the refractory block, such as zirconia–corundum blocks by adding alkali or alkaline earth metal oxides. In developing production processes for high-impact strength cast refractory blocks of varying compositions very good use was made of the impact test to determine the possible cooling program. (P.C.H.)

23238 TEMPERATURE DEPENDENCE OF THE COEFFICIENT OF FRICTION OF SOME REFRACTORY CARBIDES. Samsonov, G. V.; Tkachenko, Yu. G. (Inst. of Metals Handling, Kiev). Fiz.-Khim. Mekh. Mater.; 7: No. 3, 94-6(1971). (In Russian).

Surface friction between samples of carbides of Ti, Zr, Nb, Ta, and W was evaluated over the temperature range 0 to 1,800°C for the following combinations: TiC–ZrC, TiC–TaC, TiC–NbC, TiC–WC, and NbC–WC. Minima in the coefficient of friction were observed at 1,000, 1,050, 1,050, 900, and 1,100°C, respectively. (K.S.W.)

23239 WEAR ON METALS AND METAL-LIKE CARBIDES AT LOW TEMPERATURES IN A VACUUM. Alekseev, V. I.; Koval'chenko, M. S. (Inst. of Materials Handling, Kiev). Fiz.-Khim. Mekh. Mater.; 7: No. 3, 38-42(1971). (In Russian).

Polished specimens of metals and carbide were subjected to a glancing type of wear test conducted in a vacuum at 20°C and also at −175°C. The seven types of materials, listed in the order of decreasing resistance to wear, were WC, TiC, Co, NbC, Ti, W, and Nb, with the latter two metals being the most subject to wear under the test conditions. Wear on the Nb surface was greater at 20° than at −175°C; the other six materials manifested greater tendency to wear at the lower temperature if any difference was noted at all (Co and WC exhibited no temperature distinction in the wear tests). (K.S.W.)

23240 PHASE TRANSFORMATIONS IN MILLED ZIRCONIA. Bailey, J. E.; Lewis, D.; Librant, Z. M.; Porter, L. J. (Univ. of Surrey, Guildford, Eng.). Trans. J. Brit. Ceram. Soc.; 71: No. 1, 25-30(Jan 1972).

Tetragonal zirconia was formed at room temperature from monoclinic zirconia when the particle size was made sufficiently small by ball milling. In bulk material this transformation to the tetragonal phase only occurs above 1000°C. Surface energy considerations become important at small particle sizes and would seem to be responsible for the stability of the tetragonal phase at room temperature. Good agreement was achieved between the theoretical critical particle size, at which the tetragonal phase is expected to become stable, and that obtained by milling and by chemical preparation. When zirconia is in the critical size region, second order effects due to the presence of crystal defects, impurities or surface contamination become important in determining phase stability. (auth)

23241 X-RAY INVESTIGATION OF THE SYSTEMS (YTTRIUM, LANTHANUM, CERIUM)–(ALUMINIUM, SILICON)–BORON. Chaban, N. F.; Kuz'ma, Yu. B. Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 11, 1048-50(Nov 1971). (In Ukrainian).

By means of x-ray analysis the ternary systems {Y, La, Ce}–{Al, Si}–B were investigated and isothermal sections for {Y, La}–Al–B (600°C), Ce–Al–B (500°C) and {Y, La, Ce}–Si–B (800°C) were established. Ternary compounds were not found. The compound Y_3Si_5 dissolves to 3 at. % B and the compound YB_2–to 2 at. % Si. In the system La–Al the compound close to the composition of La_3Al_2 with the hexagonal structure was found (a = 9.26, c = 11.20 Å). (auth)

23242 CAVITATION EROSION OF COBALT BONDED TUNGSTEN CARBIDE CERMETS. Tichler, J. W.; de Gee, A. W. J. (Metal Research Inst. TNO, Delft, Netherlands). Lubric. Eng.; 27: No. 12, 428-32(Dec 1971).

The cavitation erosion resistance in water of cobalt bonded tungsten carbide cermets was studied as a function of carbide grain size and cobalt percentage. Also, the effect of intermediate exposure to humid air was studied. It was found that, under conditions of uniform material removal, cermets with 6 percent cobalt have a higher resistance against erosion than cermets with 30 percent cobalt. On the contrary, with respect to the resistance against pitting, a high cobalt percentage is favorable, in particular if applied in combination with a small carbide grain size. Probably pit formation is accelerated by a process of atmospheric corrosion along the grain boundaries. (auth)

23243 DISPERSION-HARDENED TUNGSTEN ALLOY. Landingham, Richard L.; Kane, James S. (to United States Atomic Energy Commission). U. S. Patent 3,637,422. 25 Jan 1972. Filed 3 Jan 1968.

Dispersion-hardened tungsten and tungsten alloy coatings having a material such as hafnium nitride at a concentration above 0.5 percent by volume were produced by covapor deposition of tungsten and hafnium nitride. The hafnium nitride was produced in situ by addition of ammonia or nitrogen to a reducing atmosphere of hydrogen, which was mixed with tungsten and hafnium halide vapors in the presence of a substrate mandrel heated to a temperature above 900°C. (Official Gazette)

23244 MATHEMATICAL ANALYSIS OF NONISOTHERMAL MASS TRANSFER PROCESS: APPLICATION TO OXIDATION OF CARBON WITH CO_2–CO MIXTURES. Tien, R. H.; Turkdogan, E. T. (United States Steel Corp. Research Center, Monroeville, Pa.). Carbon; 10: No. 1, 35-49(Feb 1972).

A mathematical analysis is made of the nonisothermal mass transfer occurring in reactions of gases with porous media involving appreciable enthalpy changes. The mathematical analysis of a nonisothermal reaction controlled by heat and mass transfer and by chemical reaction involves simultaneous solution of two second-order differential equations derived from the laws of conservation of mass and energy. For the purpose of demonstrating the mathematical solution, the oxidation of porous carbon in CO_2–CO mixtures is considered, on the assumption that no structural changes occur during oxidation, as would be the case in the early stages of oxidation. A similar mathematical treatment can be made for reactions of gases with other porous media. Although the thermal conductivity of coke is relatively low, it is found that the oxidation in CO_2 occurs under essentially isothermal conditions and the heat transfer to the sample is by radiation from the surface of the reaction tube. The results of the mathematical analysis were tested experimentally. During the early stages of burning in 1 atm CO_2 at 1200°C, the temperature at the center of a 22 mm dia. cylinder was found to be about 7°C below that at the surface, which was a few degrees below the furnace temperature. These findings agree with the results of the mathematical analysis. (auth)

23245 NUCLEAR FUEL BODY AND PROCESS FOR MAKING SAME. Hooker, James Ray (to United States Atomic Energy Commission). U. S. Patent 3,644,604. 22 Feb 1972. Filed 14 Nov 1969.

Porous nuclear fuel bodies are made from a mixture of a thermosetting resin, such as a phenol-aldehyde resol resin or a furfural alcohol resin, a curing agent and fuel particles having fission product-retentive coatings. The curing agent is included in an amount at least about three times the amount normally employed to completely polymerize the resin. This substantial excess of curing agent causes curing to proceed rapidly and entraps gas bubbles in the hardening polymer matrix. After curing, carbonization is carried out which leaves the coated particles dispersed in a porous carbon matrix. Fuel particle coatings, particularly pyrocarbon coatings, can form strong bonds with such thermosetting resins. The excess of curing agent avoids the establishment of stresses in the coatings that might result ultimately in cracking. (Official Gazette)

23246 FABRICATION, PROPERTIES, AND APPLICATIONS OF BERYLLIUM AND BERYLLIUM OXIDE IN ELECTRICAL ENGINEERING. PART 1. Hey, A. W.; Martin, G. Elektro-Anz.; 24: No. 7, 147-8(1971). (In German).

Beryllium, both as pure metal and in the form of beryllium oxide, is a suitable moderator and reflector for nuclear reactions. Beryllium oxide is used as competitive material for aluminum oxide in electronic circuits. Beryllium is of great importance as an alloying addition for copper, aluminum, iron, cobalt, and nickel. After a short description of the fabrication of beryllium, the manufacture of beryllium oxide and the mechanical treatment to sintered pieces, the possibilities of machining and the methods of metallization of component parts of beryllium oxide are outlined. (INIS)

23247 METHOD OF MAKING NUCLEAR FUEL-CONTAINING BODIES. Voice, Eric Handley; Graham, Leslie Wilfred; Sturge, Derek William James (to United Kingdom Atomic Energy Authority). British Patent 1,264,943. 23 Feb 1972. Filed 23 Mar 1970.

Reference is made to the manufacture of coated particle fuel containing bodies. In the process normally employed a mass of coated particles, overcoated with an adherent but deformable coating, such as a mixture of synthetic polymerization resin and graphite powder, is placed in a die and pressed into a coherent fuel containing body that may readily be handled. Although it might appear that equal size particles uniformly overcoated may on pressing result in a uniform distribution of particles within the fuel body, in practice the pressing operation generates nonuniform pressures and asymmetric flow of the overcoating material, causing a risk of interparticle contact that could lead to coating fracture, and even if such contact does not occur an irregular distribution of fuel particles within the compact may result with attendant disadvantages. In the process described at least two layers of overcoating material are applied to the fuel particles; the rheological characteristics of the innermost layer differ from those of the outer layer and the outer layer deforms to a greater extent than the inner layer. The pressing operation caused the material of the outer layer to substantially fill the interstices between the particles, while the particles remain separated by the less deformable inner layer of overcoating material. The difference in characteristics of the overcoatings is effected by varying the proportions of the ingredients in the layers or in a number of specified ways. A number of alternative process details are described. (UK)

23248 CRYSTALLIZATION OF CUBIC SOLID SOLUTIONS OF HfO_2. Spiridonov, F. M.; Perova, E. B.; Komissarova, L. N. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 5, 568-71 (Sep-Oct 1971). (In Russian).

Mixtures of coprecipitated hafnium hydroxide and certain scandium subgroup hydroxides (Sc, Y, Sm, Gd, Er) were investigated by thermal analysis and x-ray. Crystallization temperatures were found to depend on concentration and ionic radii of trivalent ele-

ments added. Metastable solid solutions of fluorite structure were formed upon crystallization in a wide range of concentrations. (auth)

23249 EFFECT OF TEMPERATURE ON THE SURFACE LAYER OF NIOBIUM CARBIDE DURING EXTERNAL FRICTION. Koval'chenko, M. S.; Tkachenko, Yu. G.; Yurchenko, D. Z.; Klochkov, L. A. (Inst. of Materials Handling, Kiev). Fiz.-Khim. Mekh. Mater.; 7: No. 4, 45-8(1971). (In Russian).

The change in microhardness of the surface layer of NbC after friction and abrasion testing was studied at temperatures (up to 1600°C) in a vacuum. Softening of the surface layer was observed beginning at 500°C which was proportional to the increase of temperature and the depth of the layer disturbed. (tr-auth)

23250 REDUCING ACTION OF SODIUM BORON HYDRIDE ON THE FORMATION OF NICKEL–BORON COATINGS. Ivanov, M. V.; Gorbunova, K. M.; Nikiforova, A. A.; Shcheredin, V. P. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 6, 1317-20(21 Aug 1971). (In Russian).

The reduction of $NiCl_2$ by $NaBH_4$ to form either Ni or Ni_2B is of both practical and theoretical interest. As an aid to the elucidation of the mechanism of this reduction, the hydrogen evolved from the reaction between $NiCO_3$, NaOD, ethylene diamine, $NaBH_4$ in 99.7% D_2O (at 95°C and a pH of 14) was analyzed for deuterium content with a mass spectrometer. The data indicate that H atoms from the $NaBH_4$ contributed substantially to the hydrogen evolved, thus substantiating the proposed mechanism. (K.S.W.)

23251 EFFECT OF THE DEGREE OF HOMOGENIZATION OF COMPONENTS ON THE FORMATION OF A SOLID SOLUTION OF CaO IN ZrO_2. Rutman, D. S.; Toropov, Yu. S.; Galkin, Yu. M.; Matveichuk, G. S. (Eastern Research and Development Inst. of the Refractory Industry, Sverdlovsk, USSR). Dokl. Akad. Nauk SSSR; 199: No. 6, 1367-9(21 Aug 1971). (In Russian).

A mixture of 0.87 ZrO_2 and 0.13 CaO was prepared by coprecipitating $CaCO_3$ and Zr hydroxide from solution. Samples were heated to 20, 380, 420, 520, 700, and 1,000°C and radiograms were recorded at these temperatures, which indicated that at 1,000°C practically all of the CaO had formed a solid solution with ZrO_2. (K.S.W.)

23252 CALIFORNIUM OXIDE SYSTEM. Baybarz, R. D.; Haire, R. G.; Fahey, J. A. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 34: No. 2, 557-65(Feb 1972).

Californium dioxide was prepared by oxidation with high pressure molecular oxygen and by atomic oxygen. The CfO_2 has a fcc structure with an expansion corrected lattice parameter of 5.310 ± 0.002 Å. Several areas of oxide stability in the range $CfO_x (2.00 > x > 1.50)$ are reported and these phases have a rhombohedral structure. The phase transition temperature between the body-centered cubic Cf_2O_3 and monoclinic Cf_2O_3 is ~1400°C. (auth)

23253 EFFECT OF RADIATION ON THE CATALYTIC ACTIVITY OF OXIDES OF RARE EARTH ELEMENTS. Spitsyn, Vikt. I.; Pirogova, G. N.; Korosteleva, R. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 6, 1356-9 (21 Aug 1971). (In Russian).

The catalytic properties of the irradiated oxides of Pr, Yb, and Er were studied in connection with the decomposition of isopropyl alcohol with its competing reactions of dehydrogenation and dehydration. Of all the oxides studied Pr_4O_7 was found to be the most active. Irradiation of the oxides was performed with slow neutrons in a nuclear reactor (1.2×10^{13} n/cm² · sec), but failed to alter the catalytic activity more than 5%. (K.S.W.)

23254 HOW MANY MORE STEPS TO ALL-JAPANESE FUEL FABRICATION. MITI REPORT DESCRIBES PROBLEMS. At. Jap.; 15: No. 6, 14-18(Jun 1971).

Present state of the Japanese fuel fabrication industry is described with special attention to associated problems and future efforts. Three years ago, all-Japanese fabricated fuel for light-water reactors was projected. The Ministry of International Trade and Industry organized a special committee of experts to look into conditions which are required to be met before Japan-made fuel can actually be used for commercial power reactors. Today, Japan-fabricated fuel is almost a reality. Fuel bundles fabricated in Japan are being used in Tsuruga BWR and Mihama-1 PWR. However, there are problems. Cost of fuel fabrication in Japan will be higher than in the U. S. Another problem pertains to definition of Japan-made fuel. Fuel fabricated under foreign license cannot be properly termed Japanese-manufacture. Third, there is the problem of performance demonstration. Japanese utilities are maintaining a firm attitude that fabricated fuel as well as its components should be based on proven technology. Japanese safety authorities also ask for lists of irradiation tests before approving fuel design. Recommendations for the future are: provision of time and extra funds to perform practical operation; effective use and expansion of post-irradiation facilities; and encouragement and joint development of core control. The current status and expansion plans of three fuel fabricators, two Zircaloy tube manufacturers, and a Pu fuel facility, are presented. (Japan)

23255 CONTRIBUTION TO URANIUM–NITROGEN SYSTEM. Katsura, Masahiro; Sano, Tadao (Osaka Univ., Suita, Japan). Technol. Rep. Osaka Univ.; 20: No. 941, 451-9(Oct 1970). (In German).

Statistical and thermodynamic studies were made on the U–N system, and interaction energies for U–U, U–N, and N–N as well as formation enthalpy for U_2N_{3+x} as function of x-value were calculated using new data for D′ sublimation enthalpy of uranium and ΔH_0^S, 298 (UN) formation enthalpy of UN at 298°C. Moreover the value obtained for formation entropy of U_2N_3, $\Delta S_0^S(U_2N_3)$, was found for the temperature range 700 to 1050°C. (Japan) (TSS)

23256 HYDROGEN HALIDE CLEANING OF POWDER METALLURGY NICKEL–20 CHROMIUM–3 THORIA. Herbell, Thomas P. (Lewis Research Center, Cleveland). Int. J. Powder Met.; 8: No. 1, 29-41(Jan 1972).

The Cr_2O_3 content of powder metallurgy nickel–20 chromium–3 thoria was reduced with atmospheres consisting of hydrogen plus hydrogen chloride (HCl) or hydrogen bromide (HBr). The non-thoria oxygen content or "oxygen excess" was reduced from an initial amount of greater than 50,000 ppM to less than 100 ppM. Low temperatures were effective, but lowest oxygen levels were achieved with the highest cleaning temperature—1200°C. (auth)

23257 UO_2 PROPERTIES AFFECTING PERFORMANCE. Lyons, M. F.; Boyle, R. F.; Davies, J. H.; Hazel, V. E.; Rowland, T. C. (General Electric Co., San Jose, Calif.). pp 1-86 of Advanced Course on Limiting Aspects of Fuel Element Performance in Water Cooled Power Reactors. Kjeller, Norway; Institutt for Atomenergi (1971).

Uranium dioxide property data are presented and the effects of important variables such as density, temperature, stoichiometry, etc. are discussed. Property data are also discussed in relation to their role in various fuel life-limiting mechanisms which have been shown to be of practical significance for UO_2 containing fuel rods. These mechanisms are principally fuel-cladding interactions, fuel swelling, hydriding of Zircaloy cladding and fission product attack on stainless steel cladding. (Norway)

23258 PHASES AND TRANSFORMATIONS IN THE CURIUM–OXYGEN SYSTEM. Mosley, W. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Inorg. Nucl. Chem.; 34: No. 2, 539-55(Feb 1972).

The thermal decomposition of curium dioxide and the polymorphism of curium sesquioxide were investigated by high-temperature x-ray diffractometry and thermogravimetric analysis. Curium dioxide has the fluorite (fcc) structure with a = 5.357 ± 0.001 Å at room temperature but radiation damage from α-decay of curium-244 causes the cell to swell to a saturation value of 5.373 Å within 3 days. Thermal decomposition of the dioxide proceeds through two intermediate phases, $CmO_{1.81}$ with apparent fluorite symmetry (a = 5.435 ± 0.001 Å) and Cm_7O_{12} with a rhombohedral cell (a = 6.677 ± 0.004 Å, α = 99.52 ± 0.07°), to form a nonstoichiometric phase $CmO_{1.64-1.52}$ with the C-type (bcc) rare earth sesquioxide structure and a lattice parameter varying between 10.922 and 10.996 Å. The C-type sesquioxide phase transforms irreversibly to monoclinic B-type Cm_2O_3 (a = 14.276 ± 0.008 Å, b = 3.656 ± 0.001 Å, c = 8.913 ± 0.004 Å, and β = 100.39° ± 0.03°) between 800 and 1300°C with a 0.1 percent weight loss. B-Type Cm_2O_3 transforms reversibly to hexagonal A-type Cm_2O_3 (a = 3.845 ± 0.005 Å, c = 6.092 ± 0.005 Å at 1650°C) at 1600°C; the A-type Cm_2O_3 is stable to the melting point. (auth)

23259 RARE EARTH OXIDE PROCESS. Ferri, John L.; Mathers, James E. (to Sylvania Electric Products, Inc.). U. S. Patent 3,635,658. 18 Jan 1972. Filed 2 Apr 1969.

A process for increasing the particle size of rare earth oxides is disclosed comprising: forming an aqueous mineral acid solution containing a rare earth source dissolved therein, reacting the rare earths in said solution with oxalic acid to form an insoluble rare earth oxalate, separating the rare earth oxalate from the reaction medium, contacting the rare earth oxalate with an aqueous oxalic acid solution having a concentration of oxalic acid of from about 1 to about 40% by weight, heating the rare earth oxalate to a sufficient temperature and time to convert said rare earth oxalates into rare earth oxides having a particle size of at least 3 microns. (Official Gazette)

23260 HOT PRESSING OF TRANSITION-METAL OXIDES. Samsonov, G. V.; Petrykina, R. Ya.; Koval'chenko, M. S. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1424-8(Sep 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 9, 1606-11(Sep 1971).

The laws of sintering were investigated by means of hot pressing of the transition metal oxides, TiO_2, ZrO_2, HfO_2, Cr_2O_3, and Nb_2O_5. Values for activation energy for sintering by hot pressing under pressures of 90 and 130 kg/cm^2 were determined. The experimentally determined dependence of the effects of temperature and pressure on the rate of compaction of powdered transition metal oxides displayed a rapidly falling initial compaction rate, followed by a gradual, almost asymptotic approach to the final density. At all temperatures compaction was characterized by a terminal velocity which increased with rise in temperature. Increase in pressure had the effect of increasing the final density attainable at a given temperature. (P.C.H.)

23261 THERMODYNAMICS OF TITANIUM, ZIRCONIUM, AND HAFNIUM OXIDES. Kulikov, I. S. (Inst. of Metallurgy, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1383-5(Sep 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 9, 1561-3(Sep 1971).

The overall and partial pressures of components over titanium oxides, ZrO_2, and HfO_2 versus oxidation potential of the gas phase at 1873°K are graphed. For each titanium oxide, the oxidation potential ranges in which a particular oxide is stable and the ranges of Ti activity in which these oxides are formed were calculated. The data may be used directly for assessing the products of deoxidation of Fe and other metals by Ti at 1873°K. Dissociation for ZrO_2 and HfO_2 was found to be the same for both. The overall pressure of the gas phase above titanium oxides, ZrO_2, and HfO_2 at 1873°K versus the oxidation potential of the gas phase are also given. The results indicate the high stabilities of these oxides, which decrease in going from HfO_2 to titanium oxides. (P.C.H.)

23262 HIGH-TEMPERATURE MICROHARDNESS AND CERTAIN PROPERTIES OF REFRACTORY OXIDES. Buntushkin, V. P.; Romanovich, I. V.; Timofeeva, N. I. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1456-7(Sep 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 9, 1638-9(Sep 1971).

The results of investigations on the high-temperature microhardness and temperature stability of simple (Y_2O_3 and HfO_2) and complex ($Y_2O_3 \cdot 2HfO_2$, $Nd_2O_3 \cdot 2ZrO_2$, $Eu_2O_3 \cdot 2ZrO_2$, $Tm_2O_3 \cdot 2ZrO_2$, and $Y_2O_3 \cdot 2ZrO_2$) oxides in a wide range of temperatures are given. Other properties of these oxides, such as melting point, structure, lattice period, density, etc. were also measured. The results of studies on the change in microhardness with temperature indicated that softening of simple and complex oxides in the range 20 to 1100°C takes place at different rates; a marked fall in microhardness by a factor of ~1 to 3 when the specimen was heated from 20 to 600°C, and a gradual fall at higher temperatures. (P.C.H.)

23263 PASSIVITY OF ZIRCONIA IN THE SYSTEM ZrO_2–SO_3–H_2O. Godneva, M. M.; Motov, D. L. Zh. Neorg. Khim.; 16: No. 9, 2382-6(Sep 1971). (In Russian).

The chemical passivity of Zr in the system $ZrO_2-SO_3-H_2O$ was studied at room temperature for five sections of the ternary diagram and also along the solubility curves of $7ZrO_2 \cdot 5SO_3 \cdot 30H_2O$ and $Zr(SO_4)_2 \cdot 4H_2O$. Lines of isopassivity are introduced and discussed. (K.S.W.)

23264 STEPWISE UPTAKE OF WATER VAPOUR BY GROUND THORIUM OXIDE. Gammage, R. B.; Brey, W. S. (Univ. of Florida, Gainsville). J. Appl. Chem. Biotechnol.; 22: No. 1, 31-7(Jan 1972).

The adsorption of water vapor and nitrogen was measured on thorium oxide ground for 500 h. The thorium oxide appeared crystalline in character with nitrogen adsorption showing mesopores but not micropores. Stepped isotherms of water and hysteresis extending to low relative pressure were found after outgassing at 200°C. After outgassing at 400°C, however, the step structure was lost, together with a reduction in adsorptive capacity close to the step height. Of the two possible explanations for the step structure, restructuring at the water–oxide interface and intercalation, the latter is favored. A pseudo-lamellar structure, involving traces of worn porcelain separating thorium oxide crystals, is suggested with entry of water molecules permitted at a critical threshold pressure. (auth)

23265 NUCLEAR FUEL. Flipot, A. J. (to Societe Belge pour l'Industrie Nucleaire, SA). Canadian Patent 880,226. 7 Sep 1971. Priority date 21 Dec 1967, Belgium.

A method is described for preparing nuclear fuel pellets with reproducible density, from particles of ceramic nuclear fuel powder. The process consists of forming the particles into agglomerates greater than 0.3 mm, grinding to granules of a size that will feed smoothly to an automatic pelletizing press, deactivating the particles subsequent to agglomeration and prior to pelletizing at a temperature of 600 to 1000°C, pelletizing the deactivated granules in a mechanical press and sintering the resultant pellets. The deactivation of the particles is carried out in a CO_2 atmosphere. (F.S.A.) (Canada)

23266 CHROMATES OF La AND THEIR SOLUBILITY IN THE SYSTEM La_2O_3–CrO_3–H_2O. Bashilova, N. I.; Tananaev, I. V.; Takhanova, E. S. Zh. Neorg. Khim.; 16: No. 9, 2566-74(Sep 1971). (In Russian).

The heterogeneous equilibrium in the system $La_2O_3-CrO_3-H_2O$ at 25°C was studied, and a ternary phase diagram was constructed showing the regions of crystallization of $La_2(CrO_4)_3 \cdot 7H_2O$ and $La_2(Cr_2O_7)_3 \cdot 7H_2O$. Solid solutions were apparently formed in regions of small concentrations of chronic anhydride in the liquid phase. The compounds which separated were identified by radiograms, and their dehydration and subsequent thermal decomposition were studied. Lanthanum bichromate, in particular, formed two intermediate products, which were converted into a lanthanum chromate, ultimately becoming $LaCrO_4$ and $LaCrO_3$ (along with Cr_2O_3). The quantitative determination of La in the presence of Cr was demonstrated. (K.S.W.)

Metals and Alloys

23267 (ORNL-4728, pp 111-77) MATERIALS DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Feb 1972.

In Molten-Salt Reactor Program.

BISMUTH A AND S—Bi-base–Li, compatibility with molybdenum, tantalum, and T-111 at 650 to 700°C

CORROSION LOOPS—operation of fused salt, for testing of MSRE materials

ELECTRONS—effects on crystal structure of graphite at 175 kV

GRAPHITE—radiation effects on crystal structure of, at 400°C, 175-kV electron

—microstructure of isotropic polycrystalline, x-ray studies of

—thermal properties of AXF-5Q and H-337 grades of, at 1000°C

—permeability of reactor grades of, measurement of helium

—permeability of, reduction by fluid impregnation and pyrolytic carbon sealing

—surface topography of pyrolytic carbon-sealed

—radiation effects on dimensional stability of, at 715°C, relations of preparation methods with neutron

HASTELLOY N—microstructure of hafnium-modified, effects of silicon additions on

—mechanical properties of titanium-modified, effects of nickel–titanium precipitation on

—weldability of modified, data tabulation on

—creep-rupture of, effects of hafnium, niobium, and titanium additions on

—corrosion by MSRE blanket and fuel salts at high temperatures, research summary on

—corrosion by steam at high pressures and temperatures

INCOLOY 800—properties for use in duplex steam generator tubing with Nickel 280

LITHIUM A AND S—Bi-base–Li, compatibility with molybdenum, tantalum, and T-111 at 650 to 700°C

MOLTEN SALT BREEDER REACTOR—materials for, development of

MOLYBDENUM—fabrication of components of, for molten salt fuel reprocessing column

—brazing and welding of molten salt reprocessing facility components of

—compatibility with bismuth containing trace lithium at 650 to 700°C

—deposition on substrates by vapor condensation, development of methods for

NEUTRONS—effects on dimensional stability of graphite at 715°C, relations with preparation methods

NICKEL A AND S—properties of Type 280, for use in duplex steam generator tubing with Incoloy 800

PACKED COLUMNS—development for reprocessing molten salt fuels

SODIUM FLUORIDES—$NaBF_4$–NaF, corrosive effects on Hastelloy N at high temperatures

SODIUM FLUOROBORATES—$NaBF_4$–NaF, corrosive effects on Hastelloy N at high temperatures

STEAM—corrosive effects on Hastelloy N at high pressures and temperatures

T-111 (TANTALUM ALLOY)—compatibility with bismuth containing trace lithium at 650 to 700°C

TANTALUM—compatibility with bismuth containing trace lithium at 650 to 700°C

TUNGSTEN—deposition on substrates by vapor condensation, development of methods for (J.R.D.)

23268 PLUTONIUM: PROBLEMS AND POSSIBILITIES. Rippon, S. E. Nucl. Eng. Int.; 17: No. 189, 85-92(Feb 1972).

Current thinking is reviewed on strategies for utilization of the large amounts of plutonium which will be produced in thermal power reactors around the world in the coming years. Technical problems associated with thermal recycle are well understood and good irradiation experience has been obtained in many power reactors in Europe and the U.S.A. The techniques for plutonium fuel manufacture are well developed but the timing for introduction of commercial scale plants and the economics of manufacture and utilization of plutonium fuel are still rather uncertain. (auth)

Corrosion and Erosion

Refer also to abstracts 22766, 22936, and 23221.

23269 (BDX-613-615) PROTECTIVE COATINGS FOR URANIUM-NIOBIUM ALLOYS. Panousis, N. T. (Bendix Corp., Kansas City, Mo.). Dec 1971. Contract AT(29-1)-613. 23p. Dep. NTIS.

Susceptibility to stress corrosion cracking in U-5 wt % Nb was significantly reduced by coating with aluminum or cadmium. Unprotected wire samples under a static tensile stress of 44,000 psi (300 N/m^2) failed after less than ½ h exposure to a 10^{-4} N KCl solution. Samples protected with aluminum or cadmium coatings lasted 1 to 4 months under similar conditions. Evidence indicated that the reduced sensitivity to attack was a result of the aluminum and cadmium sacrificially protecting the U-5 wt % Nb alloy. Four methods were used to apply the aluminum coatings: plasma spraying, thermal decomposition of triisobutylaluminum (TIBAL), electroplating, and physical vapor deposition (PVD). Plasma sprayed samples were the most extensively tested. One such sample did not fail after 129-days exposure. No failure occurred for the TIBAL coated samples; however, the relatively short exposure time of 4 days requires these results to be considered as preliminary. Samples electroplated with aluminum failed almost immediately after loading without exposure to the KCl solution. This failure is believed due to the presence of chloride in the plating bath. A PVD aluminum-coated sample failed after 30 days of exposure. Cadmium was electrodeposited from a cyanide bath. Two samples did not fail after 95 and 99 days exposure. (auth)

23270 (KFK-1463) CORROSION BEHAVIOR OF AUSTENITIC Cr-Ni STEEL AND NICKEL ALLOYS IN SUPERHEATED STEAM. Leistikow, S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung) Apr 1971. 12p. (In German). (CONF-701223-1). Dep. NTIS (U. S. Sales Only).

From Magnetic protection layer in steam generating conference; Munich, Germany (9 Dec 1970).

For the suitable selection of fuel element cladding materials for superheated steam, the extended isothermal steam corrosion of seven materials in three different preconditioning states were investigated at 600 and 620°C and 70 and 1 atm. The studies were evaluated by analyses of the steam condensates and by use of metallographic methods. The corrosion research confirmed for the low-stressed material the differentiated picture of a corrosion stability increasing with increasing nickel content and a resistance-reducing effect of chromium impoverishment and grain growth. In corrosion of the surface states cold worked by grinding with emery and rolling there is a very homogeneous picture of the corrosion stability—particularly sharply increased for the austenitic CrNi steels. The corrosion stability maintains an extended effectiveness because of the selective chromium oxidation in the metallic surface. (tr-auth)

23271 (ORNL-4745) DISSOLUTION OF LMFBR FUELS: SURVEY OF THE CORROSION OF SELECTED ALLOYS IN HNO_3-HF SOLUTIONS. Clark, Walter E.; Blanco, R. E. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 34p. Dep. NTIS.

Corrosion data are compared for a number of candidate alloys in boiling HNO_3-HF solutions of widely varying concentrations. Corronel 230, welded with strip from the parent sheet, showed the most satisfactory performance of the alloys tested in solutions that were 3 to 10 M in HNO_3 and 0.05 to 1.0 M in HF. The long-term corrosion rate in 7 M HNO_3-0.05 M HF was 1.6 mils/month. Although type 309S Nb stainless steel may be competitive in some parts of this range, Corronel 230 seemed to offer an added margin of safety. The presence of complexing agents for fluoride (e.g., Al^{3+}) and of dissolution products (e.g., UO_2^{+}, rare earths) drastically reduced the overall corrosion rates of all these alloys. In such solutions, the sensitivity of weldments to attack may be the factor that decides feasibility of use. Titanium may be usable in 12 to 15 M HNO_3 solutions that are 0.003 M in HF; the corrosion rate in 15 M HNO_3-0.003 M HF was 1.8 mils/month. Al-6061 was almost completely resistant to boiling HNO_3-HF mixtures in which the concentration of HNO_3 was 15.6 M or higher. (auth)

23272 (RD/B/N-2218) ATTAINMENT OF LOW OXIDE LEVELS IN A STATIC SODIUM POOL. Pugh, A. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1972. 11p. Dep. NTIS (U. S. Sales Only).

Experimental work is presented on the rate of purification of sodium by mass transport of oxide along an induced concentration gradient. The gradient is induced by a linear temperature gradient along the sodium column. The apparatus used is based on a theoretical study reported previously. The method of analyzing sodium samples for their oxygen content is described. Results show that a high-temperature static pool of sodium with a low level of oxide can be achieved in a practically useful time and the level maintained indefinitely, i.e., sodium temperature 520°C, oxygen level 8.5 ppM, duration 530 hours. The experimental rate of purification is much higher than predicted by the purely diffusive mass transfer theory, possibly owing to the presence of convective flows. (auth)

23273 (SC-R-722661) EFFECTS OF THE ENVIRONMENT ON THE CRACKING BEHAVIOR OF SELECTED URANIUM ALLOYS. Magnani, N. J. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 9p. (CONF-720305-2). Dep. NTIS.

From International corrosion conference; St. Louis, Mo.; (20 Mar 1972).

The uranium-base alloys U-7.5 wt % Nb-2.5 wt % Zr, U-4.5 wt % Nb, U-10 wt % Mo, and U-0.5 wt % Ti were tested in several environments to determine their susceptibility to stress corrosion cracking. The test environments ranged from <10% RH air and 100% RH air for U-10 wt % Mo to <10% RH air, 100% RH air, pure gases (O_2, N_2, CO_2, H_2), and aqueous solutions ranging from <2 to 500 ppM Cl^- for U-7.5 wt % Nb-2.5 wt % Zr. The results showed that all of the alloys stress corrosion cracked in laboratory air. Aqueous solutions containing chloride ions were more hostile to the alloys tested than laboratory air. From the results it is believed that transgranular cracking which has been observed in uranium alloys is caused by a two-stage mechanical stress corrosion cracking mechanism involving either oxidation at the crack tip and then rupture of the film or the base material below the film or the adsorption of oxygen at the crack tip and then rupture of the weakened matrix material. (P.C.H.)

23274 (TID-23690) MCR PRIMARY SYSTEM MATERIALS COMPATIBILITY. ([General Motors Corp., Indianapolis, Ind. Allison Div.]). 3 Sep 1964. 20p. Dep. NTIS.

Declassified 19 Oct 1971.

Requirements based on a literature survey and oral exchanges of the liquid metal technology of a prototype MCR are summarized. Information is included on fuel-clad compatibility, clad-coolant compatibility, fuel-coolant compatibility, structure-coolant compatibility, and clad-coolant-structure compatibility. (J.R.D.)

23275 (Y-1821) ELECTROCHEMICAL AND OTHER STUDIES OF A URANIUM ALLOY EXHIBITING STRESS-CORROSION CRACKING. Bullock IV, J. S.; Condon, J. B. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 29 Feb 1972. Contract W-7405-eng-26. 97p. Dep. NTIS.

Experiments have been carried out to characterize the electrochemistry and stress-corrosion-cracking properties of a uranium-7.5 wt % niobium-2.5 wt % zirconium alloy. Potential variations were detected on the surface of the alloy, and anodic currents were induced in air-equilibrated moisture films on the alloy. Electrochemistry of the stress-corrosion attack was found to be similar to the electrochemistry of the metal having no oxide film. Chloride ions accelerated stress-corrosion cracking apparently because of their ability to penetrate the oxide film on this alloy. Cold-worked alloy was resistant to stress-corrosion cracking, and the stress-corrosion-cracking mechanism was unrelated to a pitting-reaction mechanism. (auth)

23276 PROBLEMS OF DEGASSING OF METALS AT A HIGH MELTING POINT. Gebhardt, E.; Hoerz, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Met. Ital.; 62: No. 9, 345-52(Sep. 1970). (In Italian).

Chemical reactions of gassing and degassing high-melting metals such as Nb, Ta, Mo, and W center around oxide or nitride formation on the surface of the molten metal. The mechanics of this process are discussed. Variables which affect the absorption and transfer of nitrogen by Nb are diagrammed, and equilibria in the Nb-N system are analyzed with the aid of a set of isotherms on a pressure-concentration diagram. Similar pressure-concentration data are presented for the systems Mo-N, Ta-N, and W-N. Degassing kinetics are illustrated with oxygen concentration-time curves, and tables of activation energy and temperature data for N and O in V, Nb, Ta, Mo, and W. (K.S.W.)

23277 COMPARISON OF REFLECTION ELECTRON DIFFRACTION AND ELLIPSOMETRIC STUDIES OF THE OXIDATION OF (001) NIOBIUM. O'Neal, J. E.; Lederich, R. J.; Bellina, J. J. Jr. (McDonnell Douglas Corp., St. Louis). Met. Trans.; 3: No. 2, 599-601(Feb 1972).

The oxidation of the (001) face of niobium was investigated by ellipsometry and reflection electron diffraction in an attempt to substantiate ellipsometric results previously reported. The reflection electron diffraction data confirmed the ellipsometric interpretation that the oxidation of niobium, at pressures between 3×10^{-6} and 3×10^{-4} torr O_2 and temperatures between 450 and 600°C, consisted of oxygen dissolution in the niobium lattice followed by oxide film growth. The dissolved oxygen formed an ordered suboxide within the niobium, NbO_z, which was crystallographically oriented with respect to the niobium lattice. The oxide film subsequently formed on the surface was NbO_2. The oxidation products can be removed by sputtering which restores the single crystal niobium surface. (T.F.D.)

23278 SUPERHEATING IN THE ZIRCONIUM–OXYGEN COMBUSTION SYSTEM. Maloney, K. M.; Gupta, S. K. (General Electric Co., Cleveland). Nature (London) Phys. Sci.; 235: No. 59, 137-8(14 Feb 1972).

When a clean metal surface is exposed to attack by a gas such as O_2 under low temperature conditions reaction begins at the gas–metal interface, and if the reaction products are non-volatile an intermediate layer between the gas and metal will be formed. If, however, the rate of oxidation is sufficiently high and the amount of energy supplied by the oxidation is sufficiently large, the oxidation made in most cases changes into a different sustained rapid combustion mode. The initial rapid rise in temperature of the metal is known as the "autoignition" period when followed by a sustained period of rapid combustion. In the case of Zr "single drop" combustion in O_2 a corona is formed around the droplet after the autoignition period, attributed to gas phase reaction processes. It is shown here that the autoignition period of a Zr droplet is accompanied by superheating, and this finding is applied to the experimental results of Nelson and Levine (High Temp. Sci. 1:163 (1969)). (UK)

23279 MEASUREMENT OF STEEL CORROSION IN A HOT RADIOACTIVE ENVIRONMENT. Klewe, R. C.; Lobley, E. H.; Parr, M. K.; Richards, P. H.; Tozer, B. A. (Central Electricity Generating Board, Marchwood, Eng.). J. Phys., E (London); 5: No. 3, 203-5(Mar 1972).

Measurements of the corrosion of steel components, such as nuts and bolts, in nuclear reactors present special problems because of the restricted access and the hot (~100°C), radioactive (10 rad h^{-1}) environment which exists even during a reactor maintenance period. To operate in such conditions a small self-contained instrument package was developed which can be continuously cooled and remotely controlled. It makes use of the fact that when the beam from a high power ruby laser is focused on to a point on the surface of the corrosion layer a certain depth of the layer is penetrated. When this penetration extends down to the bare metal the surface reflectivity increases substantially, and it has been found that the depth of corrosion at any point can be measured accurately by monitoring the reflectivity of the probed area using a low-power gas laser. The reflectivity of the corroded surface to the gas laser beam was found to have a characteristic variation with the number of high-power ruby laser pulses fired and rose sharply when the corrosion layer was penetrated. By comparing the total energy required to penetrate the corrosion layer with a calibration curve obtained on samples with known corrosion depths, the depth of corrosion on the steel component can be determined. (auth)

23280 STUDY OF NICKEL PASSIVITY BY NUCLEAR MICROANALYSIS OF ^{16}O AND ^{18}O ISOTOPES. Siejka, J. (Ecole Normale Superieure, Paris); Cherki, C.; Yahalom, J. Electrochim. Acta; 17: No. 2, 161-70(Feb 1972).

The passivity of nickel in 1 N H_2SO_4 was investigated by using a nuclear microanalysis technique for the determination of ^{16}O and ^{18}O isotopes on the metal surface. It was established by ^{18}O tracing that the first monolayer of oxygen has a marked effect on the passivity of the metal. Further thickening of the film up to a maximum of about 5 monolayers seems to control the anodic current by an ion-transfer mechanism. The total quantity of oxygen found on the samples after their removal from the solution is independent of the polarization potential, due probably to further oxidation in the atmosphere. (auth)

23281 OXIDATION OF VANADIUM BY OXYGEN IN HELIUM. Kohl, H. K. (Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). Werkst. Korros.; 22: No. 12, 1008-12(Dec 1971). (In German).

Commercial He used for He-cooled reactors contains traces of O_2, H_2O, and N_2; information on corrosion of V cladding was therefore necessary. Oxidation experiments on V were conducted in the temperature range 600 to 900°C and with He–O_2 gas mixtures containing 0.11, 1.1, and 10.02 vol % O_2. From the data obtained, the dependence of the oxidation rate of V on He pressure and on O_2 partial pressure could be obtained. The change in hardness of the metal was a linear function of its oxygen content. With a He pressure of 100 bars and at 600 to 900°C, the residual O_2 in commercial He would be used up by V metal at a rate of 10^{-8} g O_2/cm · sec. (K.S.W.)

23282 CORROSION BEHAVIOR OF ZIRCONIUM ALLOYS. II. WATER VAPOR CORROSION. Jangg, G. (Technische Hochschule, Vienna); Baroch, E. F.; Kieffer, R.; Lindinger, B. Werkst. Korros.; 22: No. 12, 989-94(Dec 1971). (In German).

Zr alloys containing only a few tenths percent of Fe, Cr, and Ni (and other elements) were heated to 400°C in the presence of steam at 240 atm for six weeks as a test of the corrosion properties of the metals. The alloying elements (and others) mentioned increased the resistance to corrosion as compared to pure Zr, with the exception of Ti, which caused catastrophic attack of the Zr with which it was alloyed. Other unfavorable alloying elements were Si and Mo. (K.S.W.)

23283 PROPERTIES OF ZIRCONIUM BASE CLADDING MATERIALS. CORROSION AND HYDROGEN PICKUP. Videm, K. (Institutt for Atomenergi, Kjeller, Norway). pp 87-110 of Advanced Course on Limiting Aspects of Fuel Element Performance in Water Cooled Power Reactors. Kjeller, Norway; Institutt for Atomenergi (1971).

Under hydrogenated PWR water, the corrosion rate of zirconium-base materials is only little enhanced by irradiation. Under BWR conditions irradiation leads to about a tenfold increase in the corrosion rate of Zircaloy 2 and 4. The post-transition corrosion rate will be about 3 times higher than for PWR's. The corrosion rates both in the PWR and BWR are so low that the loss of wall thickness and the oxide film build-up has only minor consequences. Due to the oxygen in the coolant of BWR reactors the fractional hydrogen pickup will be much less in these reactors. As a consequence of this, the hydrogen pickup rate will be about the same for both reactor types (0.004 to 0.02 mg/dm² day). The maximum acceptable design limit for hydrogen is about 600 ppM. The hydrogen pickup rate of Zircaloy 2 and 4 is so high that it is likely that this design limit is reached for high-rated fuel elements with high burnup. Provided that the data are reasonably correct, Zircaloy 2 and 4 will operate so near their limits with respect to hydrogen pickup that a search for alternative zirconium alloys appears to be well justified. Fuel cladding of Zr–1% Cr–0.1% Fe has demonstrated an excellent behaviour with a low corrosion rate in the Big Rock Point reactor. Zr–2.5% Nb alloys have given considerably lower corrosion rates in loop tests than Zircaloy 2 and 4, with low hydrogen pickup. The main feature of these alloys is that the corrosion rate and hydrogen pickup are much less increased by irradiation under BWR conditions than Zircaloy 2 and 4. Autoclaving introduces some hydrogen in the material and possibly increases the corrosion rate. The process is expensive and has little value as a test. An oxide film can be made by thermal oxidation in oxygen or CO_2 and by anodic oxidation. (Norway)

23284 HANDBOOK ON CORROSION TESTING AND EVALUATION. Ailor, W. H. (ed.). Corrosion Monograph Series. New York; John Wiley and Sons, Inc. (1971). 884p. $34.95.

The practical problems and theoretical aspects of corrosion testing are discussed. Metallurgical considerations, effects of environments and temperature, and methods of corrosion evaluation are included. Laboratory methods are compared and contrasted with field and in-service testing procedures. The interpretation of corrosion test results and the significance of these results are also considered. The chapters are divided into sections on: planning and preparation of corrosion tests; laboratory corrosion testing; field and service testing; and evaluation of corrosion effects. (P.C.H.)

23285 CYCLIC OXIDATION OF HASTELLOY X. Rhee, S. K.; Spencer, A. R. (Bendix Corp., Southfield, Mich.). J. Electrochem. Soc.; 119: No. 3, 396-8(Mar 1972).

The kinetics of cyclic oxidation of sheets and wires of Hastelloy X were studied at 760 to 1200°C. It was found that the reaction can be described by the parabolic rate law. The activation energy is 49.9 kcal/mole for sheet specimens and 51.6 kcal/mole for wire specimens. (J.R.D.)

Preparation and Fabrication

Refer also to abstracts 22757, 23245–23246, and 24726.

23286 (AECL–3911, pp 35-40) EXTRUSION OF ALUMINUM, URANIUM, AND ZIRCONIUM ALLOYS AT CRNL. Nelles, J. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

A process developed by Alcan for extrusion cladding aluminum onto uranium metal rods as fuel elements for the NRU reactor has found several other applications. A subsequent design of the NRU fuel element consists of an aluminum-uranium core clad in aluminum. The core is extruded first and for cladding, twin streams of aluminum extruded through the die are forced to merge. The core is enveloped and acts as a moving floating mandrel. Two applications call for hollow co-extrusions of uranium alloys: the booster fuel for Bruce and uranium-silicon fuel for power reactors. The process is also used for making small-diameter tubes from billets of experimental zirconium alloys. (Canada)

23287 (KFK-1444) PREPARATION OF ACTINIDE/LANTHANIDE-NOBLE METAL (Pt, Pd, Ir, Rh) ALLOY PHASES BY COUPLED REDUCTION. Erdmann, Bernhard (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Oct 1971. 150p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe, Ger.

The reduction of actinide oxides (A = Th to Cm) with highly purified hydrogen in the presence of noble metals (B = Pt, Pd, Ir, Rh)—the so-called coupled reduction—results in the formation of alloy phases of AB_2, AB_3 and AB_5 compositions. In the course of the investigation the following 20 compounds have been prepared for the first time: Pt_2Am, Pt_2Cm, Ir_2Np, Ir_2Am, Ir_2Cm, and Rh_2Cm, all with the cubic Cu_2Mg-type structure; Pt_3Pa and Pt_3Np with the hexagonal Cd_3Mg- and Ni_3Ti-type structure, respectively, as well as Pd_3Np, Pd_3Am, Pd_3Cm, Ir_3Pa, Rh_3Pa, Rh_3Np, Rh_3Am, and Rh_3Cm with the ordered Cu_3Au-type of structure; Pt_5Pa with the cubic Ni_5U-, Pt_5Np with the orthorhombic Pt_5Tm-, and Pt_5Am- and Pt_5Cm- with the orthorhombic Pt_5Sm-type structure. Besides these above-mentioned alloy phases, several intermetallic phases of the lanthanide and actinide elements, as well as those of some representative and transition elements have been obtained, which have been prepared earlier by conventional techniques. Compounds such as the Pd_5Ln phases (Ln = La–Lu), Pt_2Ln (Ln = La–Gd) and Pt_3Ln (Ln = Tb–Dy) in pure form have also been obtained. In addition, investigations of the phase ratios in some systems, magnetochemical studies on Pt_3Np and Pd_3Pu, Moessbauer studies on Pt_3Np and determinations of self-irradiation effects on the compounds Pd_3Am and Pd_3Cm have been performed. Further, initial results on the preparation of certain metals (Am, Ba) from the respective platinum alloy phases are reported. (auth)

23288 (LBL-188) APPLICATION OF POWDER METALLURGY PROCESS IN THE FORMATION OF Nb_3Al SUPERCONDUCTOR. Tom, Thomas (California Univ., Berkeley. Lawrence Berkeley Lab.). Dec 1971. Contract W-7405-eng-48. 26p. Dep. NTIS.

Thesis.

The effects of process variables on the critical temperature of Nb_3Al were studied by the utilization of a powder metallurgy process. The preparation technique consisted of roll compaction of niobium powder, sintering the strip and infiltration of aluminum into the sintered strip. A heat treatment at 1530°C gave T_c values of 16.95 to 17.45°K. Two-step heat treatments gave T_c values of 11.39 to 18.27°K. The critical temperature of all samples were increased by annealing at 750°C for 18 hours. (auth)

23289 (SC-T-722464) ALPHA-GRAIN REFINING AND METALLURGICAL INVESTIGATION OF THE URANIUM ALLOY SICRAL F1 FOR FUEL ELEMENTS. Magnier, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Sandia Labs., Albuquerque, N. Mex., from report CEA-R-3905. 95p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 17223.

23290 (TID-25928) APPLICATION OF CONTROLLED ELECTROMAGNETIC FORCES DURING SOLIDIFICATION OF TYPE 304 STAINLESS STEEL. Ninth Quarterly Progress Report, July 1–September 30, 1971. Tiller, W. A.; Sherby, O. D.; Schumacher, J.; Correa, A. (Stanford Univ., Calif. Dept. of Materials Science). Contract AT(04-3)-326. 12p. Dep. NTIS.

Efforts during the quarter were directed to operation of the 25-lb ingot furnace. Experiments on steel melting crucibles are reported along with investigations of power supply and stirring coils. (J.R.D.)

23291 VAPOR DEPOSITED TUNGSTEN FOR SILICON DEVICES. Shaw, J. M. (David Sarnoff Research Center, Princeton, N. J.); Amick, J. A. Solid State Technol.; 14: No. 12, 53-7(Dec 1971).

The use of tungsten for the metallization of silicon devices and integrated circuits was investigated. The technology of depositing thin tungsten films is described, using tungsten hexafluoride as the tungsten source. Physical and electrical properties of the film are presented, including such characteristics as resistivity, hardness, adherence, and the effects on device parameters. Step-stress life tests and high temperature storage tests indicated the superiority of tungsten over aluminum in these areas. Advantages of tungsten for multilevel metallization are pointed out. (auth)

23292 PURIFICATION OF ACTIVE METALS FROM GASEOUS INCLUSIONS IN VACUUM ZONE-MELTING ALLOWING FOR THE ABSORPTION OF THE GASES. Ryabchikov, L. N.; V'yugov, P. N. Izv. Akad. Nauk SSSR, Metal.; No. 4, 58-60(Jul-Aug 1971). (In Russian).

In the vacuum zone-recrystallization of active metals, such as Zr, a portion of the gaseous impurities are absorbed rather than being simply displaced from one end of the bar to the other. Equations are derived in order to illustrate the relationship between the relative amounts of absorbed and transported gases. By using these equations the ultimate degree of purification of the active metal from gaseous impurities, e.g., O, may readily be calculated provided that the rate of absorption is known. (Metals Abstr.)

23293 SINTERING OF COMPACTS FROM MIXED NICKEL AND CADMIUM METAL POWDERS. I. Pozin, Yu. M.; Terent'ev, N. K.; Makhalov, N. A. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 695-7(Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 18-21(Sep 1971).

Studies were made on the sintering of Cd–Ni powder mixtures containing between 5 and 50% Ni. Sintering was performed at temperatures of 300 to 400°C. X-ray phase analyses showed a structure characteristic of the Ni_5Cd_{21} phase; the structure became more distinct with rise in sintering temperature and increase in Ni content. The loss of Cd was substantial in the specimens of the group that contained an excess of this metal compared with the Ni_5Cd_{21} phase, and decreased for the remaining specimens, in which the percentage Ni content was higher and alloy formation involved fuller utilization of the Cd. It was also found that specimen volume substantially increased as a result of sintering. Also, as the volume of specimens changed, so did their porosity. (P.C.H.)

23294 FORMATION OF FINE CADMIUM–COBALT POWDER ON THE CATHODE. Bryk, M. T.; Fil, T. I.; Vasilenko, V. P.; Natanson, E. M. (Inst. of Colloid Chemistry and the Chemistry of Water, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 688-91(Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 9-13(Sep 1971).

Studies were made on the conditions of formation of fine Cd–Co alloy powder, which may be used as a hydrogenation catalyst, using a two-layer bath with a revolving cathode. Electrolysis was performed in aqueous solutions of $CdCl_2$ and $CoCl_2$ with concentrations ranging from 10 to 50 g/liter. The effects of electrolyte concentration and electrolysis parameters on the chemical composition of cathodic deposits were considered. The results showed that changing the concentration of $CoCl_2$ from 10 to 30 g/liter had little effect on the Co content of the resultant metal powder deposits. Raising the electrolysis temperature to 40°C increased the concentration of Co in the deposit. The conclusions drawn on the basis of density measurements and electrochemical data were in good agreement with the results of x-ray structural analyses. An examination of the effects of current density on the shape and size of colloidal Cd–Co alloy particles showed that increasing the current density (at a constant ratio of Cd and Co ion concentrations) enhanced dendrite formation and reduced the particle size of fine Cd–Co alloy powders. (P.C.H.)

23295 PRODUCTION OF PIPING PARTS FOR RE-CIRCULATING SYSTEM IN POWER GENERATING REACTORS. Yamakami, Toshio (Nippon Steel Corp., Tokyo). Tokushuko; 20: No. 9, 20-8(Sep 1971). (In Japanese).

It is well known that piping arrangements for re-circulation systems are important to nuclear power plants, and that parts of such systems are composed of thick pipes with connectors which are usually made of stainless steel. Therefore, it is necessary to develop reliable techniques to produce perfect thick stainless steel plates, to form the plates either by cold working or by hot working, and to weld the plates incorporating solution treatment. Experience gained in the course of production of the piping parts which are installed in the re-circulating system of the power reactor, Fukushima II, of The Tokyo Electric Power Company is reviewed. The piping for the re-circulation system which is made of SUS-27 stainless steel is described along with project management. Methods of press forming and welding

are described along with welding materials and properties of welded joints. Experimental results of heat treatment of these products to increase reliability are also discussed. (Japan)

23296 NOVEL AND MODERN TRENDS IN FRENCH METALLURGY IN DEGASSING AND CONTINUOUS CASTING OF METALS. Crussard, C. (Pechiney Co., Paris). Met. Ital.; 62: No. 9, 353-62(Sep 1970). (In French).

Hydrogen and oxygen are of primary importance in working with Ti and Zr, being important constituents of alloys of these metals. Progress has been made in French metallurgy in the use of vacuum, techniques in sparging liquid metals, better understanding of the effects of hydrogen in certain metals (bubble formation and microporosity), and knowledge of the interfacial behavior between metal and inclusions. Activation analysis is used to determine oxygen, and reductive fusion in a vacuum has been introduced for hydrogen determinations. A three-minute analysis of oxygen in steel is described. Techniques in degassing aluminum, steel, and copper alloys are separately discussed. Continuous casting of uranium in a vacuum, and of thick bands of aluminum is described, and the advantages of continuous horizontal casting are outlined. (K.S.W.)

23297 ELECTROWINNING OF ZIRCONIUM FROM ZIRCONIUM TETRACHLORIDE. Martinez, G. M. (Bureau of Mines, Reno, Nev.); Couch, D. E. Met. Trans.; 3: No. 2, 571-4(Feb 1972).

The Bureau of Mines has produced ductile zirconium dendrites at 800°C in an electrolyte containing $NaCl-NaF-ZrCl_4$. Sublimed zirconium tetrachloride was fed into NaCl containing a slight excess of NaF above that required to complex 2% Zr as Na_2ZrF_6. The chlorine gas generated at the graphite anode during electrolysis was confined in and vented out of the cell through a high-density graphite tube into a scrubbing solution of NaOH. At a cathode current density of 300 A per ft^2, the zirconium metal produced was 95% + 200 mesh size. The average anode and cathode current efficiencies were 86 and 96%. The metal product in the form of arc-melted buttons has a hardness ranging from 130 to 170 Bhn and can be cold-rolled into 15-mil thick strips without intermediate annealing. (auth)

23298 CHLORINATION KINETICS OF ZIRCONIUM DIOXIDE IN THE PRESENCE OF CARBON AND CARBON MONOXIDE. Landsberg, Arne (Bureau of Mines, Albany, Oreg.); Hoatson, C. L.; Block, F. E. Met. Trans.; 3: No. 2, 517-23(Feb 1972).

Chlorination of zirconium dioxide, an important step in the commercial production of reactor grade zirconium metal, has been studied using carbon and carbon monoxide as reductants. Zirconium tetrachloride was produced when the oxide was reacted with chlorine alone above 1000°C; by introducing carbon the reaction temperatures could be lowered 200°C, and when carbon monoxide was used the reaction temperatures necessary for similar rates were even lower. With carbon monoxide the chlorination of zirconium dioxide is described by two regions differentiated by temperature and the dependence of reaction rate upon chlorine and carbon monoxide pressures. (auth)

23299 KINETICS OF DIFFUSION IN THE Nb-Al SYSTEM. Ogurtani, T. (Middle East Technical Univ., Ankara). Met. Trans.; 3: No. 2, 421-5(Feb 1972).

Diffusion kinetics were studied by varying the time and temperature (800 to 1300°C) of dipping solid niobium into molten aluminum. It was found by x-ray diffraction analysis that only the Al_3Nb phase forms at the surface of the niobium specimen and that the thickness of this layer for a given dip temperature varies parabolically with time. The activation energy and the preexponential factor of the diffusion parameter were found to be 36.5 ∓ 0.45 kcal per mole and 2.0 ∓ 0.34 cm^2 per sec, respectively. (auth)

23300 METHOD FOR THE PRODUCTION OF SINGLE CRYSTALS. Butler, Charles T.; Sturm, Bernard J. (to United States Atomic Energy Commission). U. S. Patent 3,634,033. 11 Jan 1972. Filed 10 Jun 1970.

An improved arc-fusion method for the production of high-quality single crystals at comparatively low cost is described. An arc is established in a first refractory sinterable powder pack to form a first internal cavity. A port is formed in the wall of the pack, and a second powder pack is formed within the cavity, this second pack consisting of a selected refractory sinterable powder from which single crystals are to be obtained. An arc is established in the second pack to melt only an internal portion thereof, forming a second internal cavity. Molten material derived from the second pack collects in the second cavity, cooling and crystallizing therein. A port is formed for withdrawal of the crystallized material, from which single crystals subsequently are harvested. The second cavity may be so used in additional crystal-growing runs. (Official Gazette)

23301 PROCEEDINGS OF THE RESEARCH INSTITUTE FOR NON-FERROUS METALS. Conference Held in Budapest, Hungary, May 1968. Budapest; Akademiai Kiado (1971). 502p. (CONF-680568).

Thirty-four articles are included. A separate abstract was prepared for each of three. The remaining 31 articles contain information under the broad divisions of basic and auxiliary materials of metallurgy, metallurgy, manufacture of semi-finished products, and manufacture of finished products and materials testing. (P.C.H.)

For abstracts of individual papers see: 22558, 23237, and 23302.

23302 PRODUCTION OF METALLIC VANADIUM. Varhegyi, Gy.; Vitanyi, J.; Sandor, I. (Research Inst. for Non-Ferrous Metals, Budapest). pp 271-80 of Proceedings of the Research Institute for Non-Ferrous Metals. Budapest; Akademiai Kiado (1971).

From Proceedings of the Research Institute for Non-Ferrous Metals; Budapest, Hungary (May 1968). See CONF-680568.

Vanadium metal has been produced by modification of the Kroll process, which includes reduction of vanadium trichloride with magnesium, for three years. Some general observations on the distribution of components in the reduction products, endeavors to increase the productivity of the reduction apparatus, and results of sponge processing are discussed. (P.C.H.)

23303 TEXTURE STRENGTHENING OF Ti-6A-4V. Fitzpatrick, J. M.; Crossley, F. A.; Lewis, R. E. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Metals Eng. Quart.; 12: No. 1, 27-31(Feb 1972).

Texture hardening combined with age hardening was found to increase the biaxial strength of Ti-6Al-4V alloys. It was determined that multidirectional rolling of Ti-6Al-4V alloy produced a crystallographic texture that approached the ideal basal plane texture necessary for enhanced biaxial strength. Based upon the results of the hydroburst tests, texture hardened and heat treated Ti-6Al-4V in a spherical pressure vessel would have a 41% greater strength than an isotropic alloy of the same composition, heat treated to a yield strength of 154,000 psi. For pressure vessels produced from forgings and heat treated in heavier gages, the improvement offered by textured Ti-6Al-4V would be about 50%, based on a yield strength of 145,000 psi for the heat-treated forging. (T.F.D.)

23304 BASES OF MAGNESIUM METALLURGY. Winand, Rene. Rev. Soc. Roy. Belge Ing. Ind.; No. 4, 160-72(Apr 1971). (In French).

Properties, sources, and processing of Mg are discussed, and ore and seawater resources, thermal and electrolytic extraction from oxides and chlorides, and jet refining are reviewed. Chemical and mechanical characteristics and phase diagrams of Mg-Al, Mg-Zn, Mg-Mn, Mg-Zr, Mg-Th, Mg-Ag, and Mg-Ce alloys are presented and assessed, and world production and prices from 1915 to 1968 are tabulated. (Metals Abstr.)

23305 AUSTENITIC HEAT RESISTING STEEL. (to Nippon Kokan Kabushiki Kaisha). British Patent 1,262,568. 2 Feb 1972. Priority date 25 Dec 1968, Japan.

An austenitic heat-resisting steel is described which has a nominal composition in wt % of C-0.03 to 0.30, Si-up to 1.0, Mn-up to 2.0, Cr-15 to 26.0, Ni-7 to 22.0, Nb as (Nb + Zr)/C 0.05 to 1.0, and Fe-bal. (J.R.D.)

23306 COMPOSITE METAL POWDER AND THE PRODUCTION THEREOF. Benjamin, John Stanwood (to International Nickel Ltd.). British Patent 1,265,343. 1 Mar 1972. Priority date 1 Mar 1968, United States.

An improved composite metal powder starting material is described for use in powder metallurgical processes. The composite powder can be produced without using colloidal materials, precipitated materials, co-precipitated materials, or reduced materials. The composite is made up of comminuted fragments of the starting constituents intimately united and interdispersed. (J.R.D.)

23307 PROCESSING STAINLESS STEEL TUBING FOR NUCLEAR REACTORS. Scharfstein, Lawrence R.; Wiese, Donald H. (Carpenter Tech. Corp., Reading, Pa.). Metal Progr.; 101: No. 3, 79-81(Mar 1972).

Miles of Type 316 stainless steel tubing will be used for fuel cladding in a fast test reactor now nearing the construction stage. Tight surface quality and dimensional specifications call for meticulous fabrication and testing practices. Type 316 is used because it resists molten sodium and nuclear fuel at 1,050°F, the reactor's operating temperature. (auth)

23308 WELD-CLADDING OF TUBE SYSTEMS IN NUCLEAR REACTORS. Dueren, C.; Muesch, H.; Bruehl, F. Mannesmann Forschungsber.; No. 551, 12(1970). (In German).

The welding processes, compositions of the weld and parent materials, powder and welding-conditions, and the most important factors in application of the cladding are discussed. Results of the welding depend on the polarity, current, welding rate, and temperature. These factors influence the depth of the heat-affected zone, thickness of the cladding, and mixing. The conditions must be suited for the base and addition materials. Suitable compositions are listed. Avoidance of serious embrittlement in post-weld annealing treatments is discussed, annealing at ~600°C for not more than 12 h total time with ferrite contents up to 10% in the weld cladding can be permitted without risk of danger of σ phase formation. Carburization and decarburization occurring at the fusion line are discussed and are considered not to be significant. (Metals Abstr.)

23309 INFLUENCE OF Al–Mg ALLOYS IN THE PRODUCTION OF FUEL ELEMENTS WITH Al–U–Si CORES. Iervolino, Jose Roberto; Cintra, Sebastiao Hermano Leite. Metalurgia (Sao Paulo); 27: No. 158, 31-6(Jan 1971). (In Portuguese).

The effects of alloying elements in Al alloys used for the frame and sheathing of reactor fuel-plate cores on the occurrence of end defects in the cores after roll bonding were investigated. Aluminum alloys 1100, 5052, and 5083 were tested in various combinations in framing and sheathing applications with cores of Al–20% U–0.8% Si alloy. Some of the cores were given isothermal heat treatment. Best results were obtained with sheathing and framing both of Al-5052 and a nonheated treated core. The problems created by end defects and the reasons for their appearance are reviewed briefly. (Metals Abstr.)

23310 METHOD OF WELDING VN1 AND VN2 NIOBIUM TO THE VT1 AND OT4 ALLOYS. Shchetanov, D. P. Weld. Prod. (USSR) (Engl. Transl.); 18: No. 7, 31-2(Jul 1971).

Translated from Svar. Proizv.; 18: No. 7, 18-19(Jul 1971).

The optimum parameters for electron-beam welding titanium alloys to niobium alloys and the results of mechanical tests are given. It was established that because of the different melting points of the alloys, high quality welded joints can only be made between them if the unit power input from the electron beam is accurately apportioned between the ends of the work-pieces. Tensile tests made on testpieces welded under the optimum conditions proved that in every case failure occurred through the parent titanium alloy 20 to 25 mm from the axis of the weld. Metallographic examination proved that the structure of the weld metal in specimens was typical of Ti–Ni system solid solutions, with equal percentages of both components. No welding defects were found in the weld metal. (P.C.H.)

23311 SINTERED MAGNESIUM CLADDING MATERIAL FOR URANIUM FUEL ELEMENTS COOLED BY CARBON DIOXIDE. PART I. POWDER METALLURGY OF MICROHETEROGENOUS MAGNESIUM SYSTEMS. Cech, B.; Sokol, L. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 18: No. 3, 80-3(Mar 1972). (In Czech).

The results of experimental powder metallurgy processing of magnesium composites, forming and changes of their structure, and relations between structure and mechanical properties are described. It has been proved that thermal and mechanical stability of these systems depends on the uniformity and parameters of the dispersion and on its stability in the magnesium matrix. (auth)

23312 THERMOMECHANICAL STRENGTHENING OF A γ′ PRECIPITATION-HARDENED NICKEL-BASE ALLOY. Oblak, J. M. (Pratt and Whitney Aircraft, Middletown, Conn.); Owczarski, W. A. Met. Trans.; 3: No. 3, 617-26(Mar 1972).

The advantages of using select thermomechanical processing for improving mechanical properties of γ′ strengthened nickel-base superalloys in the range room temperature to 1400°F are demonstrated. Based upon analysis of the deformation and precipitation behavior of this class of alloys, several processing conditions have been evaluated for the alloy Udimet 700. The working operation and resulting dislocation substructure were found to be of critical importance. In the preferred treatment the alloy is warm worked in the two-phase γ-γ′ condition at a temperature below that of rapid recrystallization such that a polygonal substructure is formed on the scale of the γ′ interparticle spacing. A thermomechanical treatment consisting of solution heat treatment, precipitation aging at 1950°F to form γ′, warm working to 1.50ϵ (92 pct RA) at 1950°F, plus final aging at 1550 and 1400°F was found to be beneficial for Udimet 700. The resulting property improvements included large increases in ultimate and yield strength, creep resistance, and low and high cycle fatigue resistance. These were achieved with minimal loss in ductility. The mechanical properties characterized were intended to be broad in scope and no exhaustive attempt was made to optimize processing in order to achieve maximum improvement. However, the experimental results confirmed the assessment that nickel-base superalloys can be effectively strengthened through controlled thermomechanical processing. (auth)

23313 IMPORTANCE OF BRAZING FILLER METAL APPLICATION IN HIGH TEMPERATURE BRAZING. Wysopal, R.; Bangs, E. R. (General Electric Co., Lynn, Mass.). Weld. J. (N. Y.); 51: No. 3, 97s-105s(Mar 1972).

The results of an investigation on the variables of braze filler metal paste application and its effect on brazed joint properties are reported. A program was initiated to determine the cause of rough surface appearance on brazed fillets in Ni–Cr–Si brazed Hastelloy X base material. It was discovered that variations in filler metal paste application quality have an effect on final braze joint quality. Marginal application of paste combined with variations in as-applied density and filler metal silicon content can reduce alloy flow capability. It was also found that variations in silicon content contribute to rough fillet appearance. It was concluded that the Ni–Cr–Si filler metal requires the capillary force of the braze joint interface to enable filler metal infiltration. Therefore, when applying Ni–Cr–Si filler metal paste to the braze joint, it must be firmly pressed into the capillary opening of the joint. (P.C.H.)

Properties, Structure, and Phase Studies

Refer also to abstracts 23213, 23215, 23224, 23231, 23239, and 24695–24696.

23314 (AI-AEC–13000) MECHANICAL PROPERTIES OF STAINLESS STEELS IN SODIUM, AND APPLICATION TO LMFBR DESIGN. Anderson, W. J.; Atkins, D. F.; Shively, J. H. (Atomics International, Canoga Park, Calif.). 25 Feb 1972. Contract AT(04-03)-824. 112p. Dep. NTIS.

From 1965 to 1971, Atomics International conducted a base program to determine design properties of stainless steel for the Liquid Metal Fast Breeder Reactor (LMFBR). The program content is summarized, previously reported conclusions regarding the mechanical behavior of annealed and cold-worked Types 304 and 316 stainless steel in a liquid sodium and other environments are reviewed, and previously unpublished data are presented. Experimental data were obtained in the temperature range of 900 to 1400°F. Specimens were tested under uniaxial, 1:1 biaxial, and 2:1 biaxial stress-state conditions, with emphasis on the 2:1 state. Except for a small number of test samples that were injected with helium on a cyclotron, all materials were tested in the unirradiated condition. Test environments included static and flowing high-purity liquid sodium, high-purity helium, sodium system conditions which induced carbon transfer both to and from the stainless steel, and copper-contaminated sodium. Statistical evaluations of the data were used to derive equations for parametric correlation of creep and stress-rupture strength, time, and temperature. A discussion of the application of the data to the design of LMFBR stainless steel components is included. An appendix contains a bibliography of reports published under the program. (auth)

23315 (CEA-R–4253) X-RAY MEASUREMENT OF STRESSES ON URANIUM CONTAINING 10% MOLYBDENUM BY WEIGHT. Gentil, Bernard (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jan 1972. 96p. (In French). Dep. NTIS (U. S. Sales Only).

The quenching stresses appearing in a U–10 wt % Mo alloy were studied in order to investigate their contribution to stress corrosion. The x-ray diffraction method was used. The grain size of the alloy was too large for such a method and had to be reduced. The anisotropy of the elastic constants of the material was relatively low as shown by the calibration results obtained on a bending device. Surface stresses caused in the alloy by quenching seem to be compression stresses, therefore not responsible a priori for sensitivity to stress corrosion. (auth)

23316 (COO–3459-1) PRECIPITATION AND DISPERSION HARDENING IN HCP ALLOYS. Annual Report. Stoloff, Norman S. (Rensselaer Polytechnic Inst., Troy, N. Y.). 1 Mar 1972. Contract AT(11-1)-3459. 17p. Dep. NTIS.

Developments are reported for studies on: effects of cooling rate on hydride habit planes in Hf; effects of oxygen on yield stress and fracture behavior of Hf; deformation modes in Hf; strength plateau in Hf–H alloys; and step-aging of Mg–3.7% Th–0.6% Zr. The results showed that the hydride habit plane of Hf is a function of cooling rate from hydriding temperatures. Slow cooling favored a prism habit plane, while water quenching favored basal hydrides. A plateau in strength of Hf–H alloys occurred at 4.2°K, as at higher temperatures. Severe embrittlement of Hf by O was found to be a consequence of solid-solution strengthening and the suppression of cross-slip. Oxygen induced cleavage on both {2130}

and (0001) planes. Two step aging processes in Mg–Th–Zr led to a small increase in peak yield stress, but did not have an appreciable effect on fracture behavior. (P.C.H.)

23317 (JPRS–55392) NONFERROUS METALLURGY. Translation of articles from Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 1971. 40p. NTIS.

Articles are included on wetting of titanium and chromium borides by iron-group metals, properties of $MgCl_2$-Ti-graphite systems, properties of KCl-Ti-graphite systems, reactions of ZrO_2 with C at high temperatures, mixing metal chloride vapors, properties of Cr-Ti-V-B systems, solubility of C in Nb, and neutron diffraction analysis of Nb_4N_3. (J.R.D.)

23318 (ORNL-tr-2579) STUDY OF URANIUM–TITANIUM ALLOYS WITH A LOW TITANIUM CONTENT (0 TO 1.5 PERCENT) BY WEIGHT. Linard, Michel (Commissariat a l'Energie Atomique, Valduc (France). Centre d'Etudes). Translated for Oak Ridge National Lab., Tenn., from report CEA-R-4180. 74p. Dep. NTIS.

This paper was abstracted from the original language and appeared in NSA as 26: 4935.

23319 (SC-T-722465) INFLUENCE OF THE INITIAL STATE AND RATE OF COOLING FROM THE BETA PHASE ON THE PREFERRED ORIENTATION OF URANIUM AFTER HEAT TREATMENT. Volf, F.; Slancar, F.; Kraus, V. (Ceskoslovenska Akademie Ved, Rez, Ustav Jaderneho Vyzkumu). Translated for Sandia Labs., Albuquerque, N. Mex., from report UJV–2525-M. 29p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 29884.

23320 (SC-T-722467) X-RAY TOPOGRAPHY OF URANIUM ALLOYS. Le Naour, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Sandia Labs., Albuquerque, N. Mex., from report CEA-R–3494. 45p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 52198.

23321 (TID–25905) STEEL PROGRAM OF EURATOM, 1967. (Metaalinstituut TNO, Delft (Netherlands)). 151p. Dep. NTIS.

Work performed under United States–Euratom Joint Research and Development Program.

Four quarterly reports were compiled as an annual report. Summaries are given for studies on: effects of nitrogen in Fe and steel under fast neutron irradiation; radiation effects on embrittlement in steel using small specimens (≈0.2 cc); long-term mechanical properties of metals subjected to mechanical stress at elevated temperatures and neutron irradiation; mechanical properties and corrosion resistance of pure Fe–Cr–Ni stainless steel; and effects of plate thickness, applied stress, and temperature on brittle fracture behavior in the Robertson-test. (P.C.H.)

23322 (TID–25906) STEEL PROGRAM OF EURATOM, 1966. (Metaalinstituut TNO, Delft (Netherlands)). 279p. Dep. NTIS.

Work performed under United States–Euratom Joint Research and Development Program.

Four quarterly reports were compiled as an annual report. Summaries are given for studies on: effects of nitrogen in Fe and steel on the behavior of these metals under irradiation; development of a new method for determining the transition temperature of steels; embrittlement of reactor vessel steels by plastic fatigue; embrittlement in irradiated steel using small specimens; long-term mechanical properties of metals subjected to mechanical stress at elevated temperatures and neutron irradiation; imperfections in metals, corrosion and oxidation; in-pile corrosion of nuclear materials; and mechanical properties and corrosion resistance of pure Fe–Cr–Ni stainless steels. (P.C.H.)

23323 (TID–25907) STEEL PROGRAM OF EURATOM, 1965. (Metaalinstituut TNO, Delft (Netherlands)). 240p. Dep. NTIS.

Work performed under United States–Euratom Joint Research and Development Program.

Four quarterly reports were compiled as an annual report. Summaries are given for studies on: effect of nitrogen in Fe and steel on the behavior of these metals under irradiation; development of a new method for determining the transition temperature of steels; embrittlement by plastic fatigue of reactor vessel steels; long-term mechanical properties of metals subjected to mechanical stress at elevated temperatures and neutron irradiation; and imperfections in metals–corrosion and oxidation; in-pile corrosion of nuclear materials; and behavior of stainless steels in water vapor at high temperature. (P.C.H.)

23324 SODIUM-WATER REACTION AND TRENDS OF RESEARCH IN THIS DOMAIN. Isshiki, Naotsugu (Tokyo Inst. of Tech.); Hori, Masao. Nippon Genshiryoku Gakkaishi; 14: No. 1, 15-20(Jan 1972). (In Japanese).

Much study has been undertaken in recent times in Japan and in other countries on the sodium–water reaction. These studies can be classified into three categories: large leak phenomena; small leak phenomena; and detection and safety aspects of the reaction. The principal trends and present status of Japanese studies in each category are given. A description is also given of some of the important research facilities and their activities. (auth)

23325 NEW HIGH-STRENGTH STAINLESS STEELS. Evans, H. E. (Central Electricity Generating Board, Berkeley, Eng.). Nature (London); 235: No. 5335, 219-20(28 Jan 1972).

Austenitic stainless steels containing a dispersion of TiN are discussed. TiN has a large negative free energy of formation and is much more stable than other dispersed phases occurring in the steel. The alloy may be formed by the high-temperature diffusion of N_2 into a steel containing Ti in solution, subsequent reaction producing a dispersion of TiN. Data are given for the variation of room temperature Vickers hardness with nitriding time; a marked increase in hardness occurred, reaching a maximum in 10 to 16 h, corresponding to a uniformly hardened structure. This level of hardness was maintained for nitriding periods of up to ~300 h. Data are also given on the very large improvements in creep strength. Ductility was within the range 2 to 6%, as measured by the strain to the onset of tertiary creep. The studies carried out were preliminary to assessing the suitability of the materials for reactor fuel element cladding. (UK)

23326 INFLUENCE OF THE REDUCTION VALUES ON TEXTURE FORMATION IN ZIRCALOY TUBING PRODUCED WITH LOW DEFORMATIONS. Tenckhoff, Erich; Rittenhouse, Philip L. (Oak Ridge National Lab., Tenn.). Z. Metallk.; 63: No. 2, 83-8(Feb 1972).

In the fabrication of Zircaloy tubing with deformations more commonly used in commercial tube reduction processes, the development of texture is determined primarily by the ratio of wall-to-diameter reduction. The influence can be followed step by step for all reduction passes. Neither fabrication method (rocking, mandrel drawing, planetary ball swaging, hammer swaging) nor a change in the deformation direction causes significantly different textures when the processes are done with corresponding reductions in wall thickness, diameter, and area. The observed textures and texture gradients are explained by consideration of the deformation applied and the resulting strains in the wall of the tube. (auth)

23327 THERMAL TRANSPORT OF INDIUM IN SILVER. Heitkamp, D. (Institut fuer Physikalische Chemie, Juelich, Ger.). Z. Phys. Chem. (Frankfurt); 76: No. 5-6, 328-30(Dec 1971). (In German).

The diffusion kinetics were measured using ^{114m}In as tracer. The concentration of In in Ag as a function of temperature is represented by a straight line. An expression for the temperature-concentration relation is also included. (J.R.D.)

23328 NUCLEATION MECHANISM IN A Ni–Cr–Nb–Co ALLOY AT 1150 °C QUENCHED IN WATER AT 20°C AND TEMPERED AT 700°C. Houvion, J. P.; Gantois, M. (Ecole Nationale Superieure de la Metallurgie et de l'Industries des Mines, Nancy). Compt. Rend., Ser. C; 273: No. 22, 1497-9 (29 Nov 1971). (In French).

An electron microscope was used to study the nucleation and particle development during precipitation in a Ni–Cr–Nb–Co alloy. A nucleation mechanism is proposed. (France)

23329 ALUMINUM AS A CHEAP SHIELDING MATERIAL FOR PURE BETA-EMITTERS. Mishra, Indu Shekhar; Sahu, T. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri); 7: No. 4, 325-7(Oct-Dec 1970).

The maximum penetration of β-particles of energy 1.17 MeV in aluminum is determined and found to be 446 mg/cm^2. It is suggested that aluminum can very well be used in the construction of β-shells and β-glove boxes in place of imported perspex sheets or any other material. (auth)

23330 CONSTITUTION DIAGRAM OF THE SYSTEM CERIUM–GERMANIUM IN THE 50 TO 100 AT. PERCENT GERMANIUM RANGE. Eremenko, V. N.; Zyong Kuok Shi; Buyanov, Yu. I.; Khar'kova, A. M. (Inst. of Materials Science, Kiev. Kiev State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 9, 717-19(Sep 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 9, 46-9(Sep 1971).

A study was made on the phase diagram of the system Ce–Ge in the region of Ge-rich alloys. The results obtained made it

possible to construct a phase diagram of the system Ce–Ge in the range from 50 to 100 at.% Ge. The existence of the monogermanide CeGe with the FeB crystal structure was confirmed. A thermogram and dilatogram of an alloy with 50 at.% Ge revealed no signs of solid-state transformation. Specimens of this alloy in the as-cast condition and annealed at 1200 and 400°C have the same crystal structure. It was concluded that the phase diagram of the Ce–Ge system in the 50 to 100 at. % Ge range is analogous in structure to the phase diagrams of the La–Ge system. (P.C.H.)

23331 TEMPERATURE DEPENDENCE OF THE CRITICAL RESOLVED SHEAR STRESSES FOR BASAL AND PRISMATIC SLIP IN BERYLLIUM. Turner, G. I.; White, J. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Scr. Met.; 6: No. 2, 123-5(Feb 1972).

The critical resolved shear stresses for basal and prismatic dislocations in Be were measured at 300 to 500°K. It was found that crystal purity and strain measurement sensitivity affect results and should be evaluated when such results are correlated with those obtained by other investigators. (J.R.D.)

23332 PRECIPITATION OF THE METASTABLE CUBIC Al_3Zr-PHASE IN SUBPERITECTIC Al–Zr ALLOYS. Nes, E. (Central Inst. for Industrial Research, Oslo). Acta Met.; 20: No. 4, 499-506(Apr 1972).

The decomposition of Zr in Al–0.18 wt. % Zr alloys was examined by transmission electron microscopy. The precipitating phase was the metastable cubic Al_3Zr, which, during annealing at 460°C, was found to be stable within the investigated time ranges (maximum 700 h). The lattice constant of the cubic Al_3Zr cell has been measured to 4.08 Å. The precipitate nucleation was heterogeneous on dislocations and subgrain boundaries. The precipitation kinetics was diffusion controlled and from the growth rate of the precipitate particles the diffusivity of Zr in Al has been estimated to about 10^{-11} cm^2/sec. The morphology were mostly spherical, while also rod-shaped precipitates, oriented in ⟨100⟩ matrix directions and plates on {100} matrix planes were observed. In addition more irregularly shaped particles or clusters of particles appeared. (auth)

23333 MECHANICAL RELAXATION AND DIFFUSION OF INTERSTITIAL ATOMS IN H.C.P. METALS. Browne, K. M. (Central Research Lab., Newcastle, Australia). Acta Met.; 20: No. 4, 507-14(Apr 1972).

Two types of mechanical relaxation of interstitial atoms occupying octahedral interstices in hcp metals are possible. These are relaxation of interstitial–substitutional (i–s) pairs and relaxation of interstitial–interstitial (i–i) pairs. It was demonstrated that both relaxations have been detected by internal friction methods for the case of oxygen in titanium. The relationships between the diffusion coefficient and the relaxation frequencies for the two types of relaxation were determined; these were used to identify the type of relaxation associated with internal friction peaks previously reported in hafnium–oxygen and zirconium–oxygen alloys. (auth)

23334 FINE SUBGRAIN STRUCTURE ADJACENT TO FATIGUE CRACKS. Grosskreutz, J. C.; Shaw, G. G. (Midwest Research Inst., Kansas City, Mo.). Acta Met.; 20: No. 4, 523-8(Apr 1972).

Deformation microstructures adjacent to fatigue cracks in 2024-T4 and 7075-T6 aluminum and Ti–6Al–4V alloys have been examined by transmission electron microscopy. The data show that material within 1 to 2 μm of a tensile-mode crack consist of very fine (0.1 μm) subgrains in all three materials. The average misorientation between the subgrains is 2 to 4°. The presence of this substructure, which seems to be independent of initial metallurgical condition, was used to explain the weak dependence of stage II crack growth rates on the initial condition in high stacking fault energy materials. No evidence of precipitate reversion was observed adjacent to the fatigue cracks in 7075-T6 aluminum. (auth)

23335 INFLUENCE OF PRE-STRAIN ON DEFORMATION TWINNING IN NIOBIUM SINGLE CRYSTALS. Boucher, N. A.; Christian, J. W. (Oxford Univ.). Acta Met.; 20: No. 4, 581-91 (Apr 1972).

Single crystals of niobium were grown by the electron beam floating zone technique and purified by annealing in ultrahigh vacua. Crystals orientated for either single or double slip were predeformed at room temperature or 158°K in order to investigate the effects of various dislocation distributions on the twinning behavior. It was found that pre-strain always raises the twinning stress and that more twins form in prestrained specimens. Pre-strain at 158°K in both double and single slip orientations and at nontemperature in double slip orientations, was effective in suppressing twinning at temperatures down to 77°K, but not at 55°K and below. The twinning stress continued to increase slightly with decreasing temperature down to 20°K and there was evidence that twinning is always accompanied by some slip. In very pure pre-strained crystals, twinning was not restored by annealing. It was concluded that a homogeneous distribution of dislocations is the main requirement for effective twin suppression and that dislocations which intersect the twinning plane are more effective than those which are parallel to it. A possible nucleation mechanism is the dislocations of screw dislocations, formed by micro-slip, at or below the macroscopic yield stress at which these dislocations move. (auth)

23336 BULK SELF-DIFFUSION OF ^{181}Hf IN MONOCRYSTALLINE ALPHA HAFNIUM–2.1 PERCENT ZIRCONIUM. Davis, B. E. (Babcock and Wilcox Co., Lynchburg, Va.); McMullen, W. D. Acta Met.; 20: No. 4, 593-9(Apr 1972).

Coefficients for the diffusion of ^{181}Hf (43 day half-life, main γ peak at 482 keV) were measured in the [0001] and [11$\bar{2}$0] directions in oriented single crystals of hcp Hf–2.1 wt % Zr over a temperature range of 1074 to 1610°C. A lathe sectioning technique was used in conjunction with the thin-film solution. Self-diffusion coefficients at temperatures between 1220 and 1610°C for diffusion parallel and perpendicular to the c axis, respectively, may be expressed as follows: $D_{\|c} = 0.86 \exp[(-88{,}400 \pm 3200)/RT]$ cm^2/sec and $D_{\perp c} = 0.28 \exp[(-83{,}200 \pm 4800)/RT]$ cm^2/sec. These expressions agree with rules-of-thumb applicable to the "normal" lattice self-diffusion behavior found in most metals but disagree with previously reported self-diffusion data for polycrystalline α Hf, Zr and Ti which indicate anomalous self-diffusion behavior. Below 1220°C the Arrhenius plots bend upward and, because of scatter, the data are only approximated by the following expressions: $D_{\|c} = 7.1 \times 10^{-11} \exp[(-20{,}300 \pm 6400)/RT]$ cm^2/sec and $D_{\perp c} = 8.9 \times 10^{-10} \exp[(-24{,}900 \pm 13{,}200)/RT]$ cm^2/sec. The low temperature results probably do not represent Harrison's type A diffusion but are significantly influenced by short-circuiting. The results are consistent with the short-circuiting model of Lundy and Pawel, and the anisotropy of the lattice self-diffusion is consistent with that of the other hcp metals for which single crystals have been studied in that $D_{\perp c} > D_{\|c}$ for a metal of less than ideal c/a ratio. (auth)

23337 STUDY OF MECHANICALLY STRAINED BERYLLIUM–IRON ALLOYS BY MOESSBAUER EFFECT. Janot, C.; Delcroix, P. (Laboratoire de Physique du Solide, Nancy). Acta Met.; 20: No. 4, 637-43(Apr 1972). (In French).

Beryllium monocrystals with 1 wt % iron in supersaturated solution were studied by unidirectional compression. With strain perpendicular to the basal plane, no plastic deformation was observed and rupture occurred almost just after the critical stress; Mössbauer spectrum showed the low reversible changes of c/a. Inversely, with compression parallel to the basal plane, a sensible change of the quadrupolar effect in relation with the plastic deformation occurred; rupture dose progressively by nucleation of a second phase. Evidence of the characteristic effect of the plastic deformation on the electric field gradient is given. (auth)

23338 MODERN METALLOGRAPHIC TECHNIQUES AND THEIR APPLICATIONS. Phillips, Victor A. New York; John Wiley and Sons, Inc. (1971). 545p. $27.50.

Emphasis is placed on principles rather than detail wherever references can be made to other sources of detailed information. Discussions are included on metallographic methods of revealing structure, microindentation hardness testing, optical microscopy, low-energy electron diffraction and Auger electron analysis, conventional electron microscopy, specialized electron microscopy, x-ray microscopy, and electron microprobe analysis. (J.R.D.)

23339 SINTERING OF MIXTURES OF Cd-, Pb-, AND Sn-POWDERS ABOVE THE TERNARY EUTECTIC TEMPERATURE. Dirks, A. G.; Meijering, J. L. (Technical Univ., Delft, Netherlands). Scr. Met.; 6: No. 2, 175-80(Feb 1972).

Results of a dilatometric study of Cd–Pb–Sn system at 145 to about 160°C are presented in graphs and tables. It was found that Cd behaves normally but Pb shows growth of unknown origin. Tin begins to grow abnormally when the temperature exceeds 160°C. (J.R.D.)

23340 IMPROVEMENTS IN AND RELATING TO POROUS METAL STRUCTURES. Armstrong, Edward (to Darchem Engineering Ltd.). British Patent 1,262,467. 9 Feb 1972. Filed 1 May 1968.

A porous metal structure is described that is claimed to be particularly suitable as a sound absorber where high levels of sound are concerned, such as with nuclear reactors, where the noise due to blowers and other apparatus may rise as high as 180 db. The structure comprises a random mass of helically wound metal wire compressed to the desired shape and with adjacent lengths of wire engaging with one another so that the structure retains its shape. The random mass of wire may be mixed with braz-

ing alloy and brazed to assist in maintaining the desired shape, or may be moulded into shape. Stainless steel is a suitable material, with a Ni-based brazing alloy. The properties of the product may be controlled by regulating the compression of the wire and/or by suitably selecting the wire diameter; also regulating the tightness of the spring into which the wire is coiled. (UK)

23341 E.m.f. MEASUREMENTS IN VANADIUM–OXYGEN SOLID SOLUTIONS WITH ThO_2–Y_2O_3 ELECTROLYTES. Fromm, E.; Kirchheim, R. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 26: No. 3, 403-6(Mar 1972).

The terminal solubility of O in V was measured by the emf method. The solubility values obtained were plotted vs temperature. The values agreed well with results obtained by others. The thermodynamics of the reaction are also discussed. (P.C.H.)

23342 CHEMICAL TRANSPORT REACTIONS IN THE HIGH TEMPERATURE REGION OF THE SYSTEM TUNGSTEN–CHLORINE. Neumann, G. M.; Mueller, U. (OSRAM-Studiengesellschaft, Munich). J. Less-Common Metals; 26: No. 3, 391-7(Mar 1972). (In German).

Chemical transport reactions in the high temperature region of the system tungsten–chlorine have been followed by observing the growth of tungsten deposits—needle-like and dendritic growth forms—using a simple experimental arrangement with chlorine pressures between 1×10^{-3} and 5×10^{-2} atmospheres. The observed directions of transport are in fair agreement with theoretical calculations of the reaction equilibria from the basic principles of thermodynamics. (auth)

23343 BINARY SYSTEM ZnO–Nb_2O_5. Dayal, R. R. (Dept. of Energy, Mines and Resources, Ottawa). J. Less-Common Metals; 26: No. 3, 381-90(Mar 1972).

Phase relationships in the binary system ZnO–Nb_2O_5 have been re-determined. The compounds $3ZnO \cdot Nb_2O_5$, α-$ZnO \cdot Nb_2O_5$, β-$ZnO \cdot Nb_2O_5$, and $2ZnO \cdot 17Nb_2O_5$ have been encountered. The compounds $3ZnO \cdot Nb_2O_5$ and β-$ZnO \cdot Nb_2O_5$ melt congruently at 1312 and 1405°C, respectively, but $2ZnO \cdot 17Nb_2O_5$ melts incongruently to liquid + H-Nb_2O_5 at 1415°C and exists at temperatures above 1085°C. The $\alpha \rightleftharpoons \beta$ polymorphic transition in $ZnO \cdot Nb_2O_5$ occurs at 1350°C. X-ray powder diffraction data for α-$ZnO \cdot Nb_2O_5$, β-$ZnO \cdot Nb_2O_5$, and $2ZnO \cdot 17Nb_2O_5$ are given. (auth)

23344 NOTE ON THE STRUCTURE AND OCCURRENCE ON YTTERBIUM TRANSITION METAL COMPOUNDS. Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals; 26: No. 3, 329-33(Mar 1972).

The binary systems Yb–Ni, Yb–Co, and Yb–Fe were studied by x-ray diffraction methods. The number of compounds observed in these systems was six, three and two, respectively. For most of these compounds the crystal structure and the lattice parameters are given. Compared with other rare earth transition metal systems the investigated systems contained relatively few compounds. This is discussed in terms of a size-dependent stability of the structures and a variable valency of the ytterbium atoms. (auth)

23345 ROLE OF HAFNIUM IN MODIFYING THE MICROSTRUCTURE OF CAST NICKEL-BASE SUPERALLOYS. Kotval, P. S.; Venables, J. D.; Calder, R. W. (Research Inst. for Advanced Studies, Baltimore). Met. Trans.; 3: No. 2, 453-8(Feb 1972).

The effects of hafnium additions on the microstructure of ALLOY 713-LC have been investigated using electron microscopy and by a radiographic technique which reveals the grain boundary structure. It was found that the chinese script MC carbides in ALLOY 713-LC were altered to a particulate morphology in alloy MM-004 (hafnium-modified ALLOY 713-LC). Unlike the script carbides, the discrete MC particles did not provide any easy path for rapid crack propagation and hence, ductility was enhanced. In the hafnium-bearing alloy, the morphology of γ' phase was also modified. Colonies of $(\gamma + \gamma')$ with a rosette morphology were formed and individual γ' platelets exhibited dendritic growth. It was found that the morphology of γ' caused grain boundaries to be distorted from planar equilibrium interfaces to a convoluted interlocking configuration. It is suggested that the interlocking boundaries retard grain boundary sliding and separation during creep and result in higher stress-rupture life for hafnium-modified alloys. (auth)

23346 ENVIRONMENTAL HYDROGEN EMBRITTLEMENT OF AN $\alpha-\beta$ TITANIUM ALLOY: EFFECT OF MICROSTRUCTURE. Nelson, Howard G.; Williams, Dell P.; Stein, James E. (Ames Research Center, Moffett Field, Calif.). Met. Trans.; 3: No. 2, 469-75(Feb 1972).

Environmental hydrogen embrittlement of a Ti–6Al–4V alloy has been studied as a function of test displacement rate and of variations in $\alpha-\beta$ microstructure. Embrittlement in low pressure (~1 atm) gaseous hydrogen was inversely dependent on test displacement rate and strongly dependent on microstructure. At a given displacement rate, microstructures having a continuous α-phase matrix were less severely embrittled than those having a continuous β-phase matrix. Further, brittle fracture occurred in the former microstructures by transgranular cleavage and in the latter microstructures by intergranular separation. These observations are consistent with previous studies made on slow strain-rate embrittlement of hydrogen-charged titanium alloys and are explained in terms of relative hydrogen transport rates within the α-phase and β-phase titanium. (auth)

23347 INVESTIGATION OF THE ABNORMAL SNOEK PEAK IN THE IRON–VANADIUM–NITROGEN SYSTEM. Welch, William Davis Jr. Denver; Univ. of Denver (1971). 149p. University Microfilms Order No. 72-2135.

Thesis.

An experimental investigation of the anelastic behavior of the Fe–V–N alloy was carried out using both internal friction experiments and experiments which measured stress relaxation at constant strain. Both types of experiments were performed on samples which were used as the suspension in an inverted torsional pendulum. The investigation was undertaken to explain the occurrence of the additional internal friction peak which is observed when V is added to the Fe–N system. Here "additional" means in addition to the internal friction peak, denoted the Snoek peak (Snoek, 1941), occurring in the Fe–N system. The additional peak, denoted the abnormal peak, has a peak temperature of approximately 88°C for a measurement frequency of .5 Hz. For the same measurement frequency the Snoek peak has a peak temperature of approximately 15°C. The Snoek peak has been well documented and is due to stress induced reorientation of N about first neighbor octahedral sites of an Fe atom. The abnormal peak is not due to a single type of stress induced reorientation. The investigation examined the effect of both V and N concentration on the abnormal peak and also examined it as a function of the frequency of measurement. Samples containing .51, 1.02, and 1.45 wt % V were used for the investigation. The N concentration in the samples was controlled by a time at temperature nitriding process. The samples were found to absorb one N atom for every V atom in the region into which N had diffused before internal friction peaks, in the temperature range 10 to 175°, were observable. A curve fitting analysis was used to separate the abnormal peak into Debye peaks. All abnormal peaks as a function of V and N concentration as well as a function of frequency were forced fit with three Debye peaks having parameters which indicated they were due to interstitial diffusion. Relaxation experiments confirmed the curve fitting analysis and indicated two additional processes were present which would cause Debye peaks to occur above the abnormal peak temperature. The two additional peaks were not observed because the damping they produced was below background damping. Defect models to explain the observed experimental behavior were examined. A defect model was found which explains the interstitial diffusion process causing the three Debye peaks composing the abnormal peak. The model also shows the two additional relaxation processes not causing observable Debye peaks are also due to interstitial diffusion. The defect model is a N atom in a first neighbor tetrahedral site about a substitutional V atom having N atoms in either or both first neighbor octahedral sites about the tetrahedrally positioned N atom. The N atom in the tetrahedral site was considered to be bound in the sense that it does not show its expected Debye peak in the temperature range examined in the present investigation. Energetically nonequivalent octahedral-tetrahedral-octahedral (OTO) diffusion jumps by N from the octahedral sites explain the occurrence of the three observable and two non-observable Debye peaks. A nitrogen atom in either octahedral site has three possible OTO diffusion paths. Of the six possible stress induced OTO diffusion jumps of N from the octahedral sites only five are energetically nonequivalent. An identification of the five experimentally observed diffusion processes with the five OTO diffusion jumps predicted by the defect model was made. (Diss. Abstr. Int., B)

23348 DIFFUSION OF HYDROGEN IN LIQUID IRON ALLOYS. Depuydt, P. J.; Parlee, N. A. D. (Stanford Univ., Calif.). Met. Trans.; 3: No. 2, 525-32(Feb 1972).

Rates of absorption of hydrogen in stagnant liquid iron and ten (Fe–X) binary iron alloy systems were studied by an unsteady-state gas-liquid metal diffusion cell technique. These rates were found to be controlled by diffusion of hydrogen in the liquid phase. Chemical diffusion coefficients (D_H) were measured in pure iron and Fe–X alloys in the following (at. %) composition ranges: Mn (0 to 5), Cr (0 to 25), V (0 to 25), Nb (0 to 10), Mo (0 to 25), W (0 to 5), Ni (0 to 75), Co (0 to 75), Sn (0 to 10), and Cu (0 to 25). All measured D_H values at 1600°C were between 7×10^{-4} and 16×10^{-4} cm² per sec. The diffusion coefficients found for pure iron can be represented by $D_H^{Fe} = 4.37 \times 10^{-3} \exp(-4134 \pm 1012)/RT$ cm²/sec where the uncertainty in the activation energy, Q, in

cal per mole, corresponds to the 90% confidence level. A linear relationship was found between the logarithm of the hydrogen diffusion coefficient D_H^{Fe-X} and the interaction parameter ϵ_H^X for low and medium concentrations of alloying element X, when applied to a fixed concentration of X(5 or 25 at %) and to individual periods in the periodic table. A useful linear correlation also appeared to exist between log D_H^{Fe-X} and hydrogen solubility for fixed concentration of X and with respect to the period in which X was found. (auth)

23349 Fe–Cr–Nb PSEUDOBINARY EUTECTIC ALLOY. Jaffrey, D.; Marich, S. (BPH Melbourne Research Labs.). Met. Trans.; 3: No. 2, 551-8(Feb 1972).

A study has been made of the microstructure and some high-temperature mechanical properties of a unidirectionally solidified, pseudobinary Fe–Cr–Nb eutectic alloy. The alloy consists of 22 vol % of an intermetallic phase in an iron–chromium solid solution matrix. At all solidification rates investigated the eutectic solidified with a cellular solid/liquid interface. The minor phase adopted a fibrous growth morphology except at cell boundaries where it had a plate-like morphology. The system was found to be resistant to microstructural changes at temperatures of up to 1100°C. Fiber reinforcement however was not observed; the strength of the alloy at elevated temperatures was mainly governed by the properties of the matrix phase. (auth)

23350 X-RAY DIFFRACTION AND TRANSMISSION ELECTRON MICROSCOPY STUDY OF RECOVERY AND RECRYSTALLIZATION IN NIOBIUM AND NIOBIUM–40 VANADIUM. Guthrie, Paul Vincent Jr. Cincinnati; Univ. of Cincinnati (1971). 339p. University Microfilms Order No. 72-1455.

Thesis.

The isothermal recovery of heavily cold-rolled niobium and a niobium-40 wt percent vanadium alloy was studied using x-ray diffraction techniques, transmission electron microscopy, and hardness. Prior to the initiation of recrystallization in niobium, the effective particle size, root mean square strain, integral breadth, and hardness all recovered linearly with the logarithm of annealing time. Recovery in niobium could be divided into four time and temperature dependent regions: Region I, annealing out of excess point defects leading to strain aging effects; Region II, annihilation and rearrangement of dislocations within cell walls and attraction of interior dislocations to the cell walls, resulting in the formation of subgrains; Region III, normal subgrain growth through the elimination of common subgrain boundaries; and Region IV, formation of abnormal subgrains and their growth by boundary migration, leading to recrystallization. Activation energies increased with increasing recovery, varying continuously from ~30,000 cal/mole at zero recovery to ~98,000 cal/mole at complete recovery. The former value is in good agreement with the activation energy for the migration of point defects in niobium, while the latter value closely coincides with the self-diffusion activation energy. Calculations based on various recovery models support dislocation climb as the principal rate controlling mechanism, provided the activation energy for diffusion is allowed to vary with the state of perfection of the lattice. Recovery of the alloy occurred in a different manner. No large scale regrouping of dislocations was observed during the early stages of recovery, with the initial dense, random dislocation array tending to anneal out uniformly. Patches consisting of stress-eliminating arrays dispersed in a matrix of random dislocations developed. As recovery continued, large scale rearrangements of dislocations into cell-like configurations took place, with the stress-free networks possibly providing the nuclei for the formation of low-angle cell walls. These cells became the nuclei for recrystallization as their interiors became sufficiently clear of dislocations. Subsequent migration of these boundaries left a trail of "hairpin" shaped dislocation loops extending radially into each recrystallization nucleus. A mechanism of grain boundary glide is discussed, whereby individual boundary dislocations encountering a sufficiently high resistance to glide are left behind the migrating wall by the production and extension of kink or jog pairs. Niobium-40 vanadium is more resistive to continued recovery than pure niobium with regard to either applied or homologous temperatures in the range of 500 to 800°C. Such behavior, in contradiction to the apparent self- and inter-diffusion activation energies, is related to the nature of the as-deformed dislocations substructures and the manner in which they recover. The effective particle size determined from x-ray diffraction was not found to be a measure of the average dislocation cell or subgrain size determined by transmission electron microscopy. No simple correlation was found between these two parameters, although both were found to increase uniformly for increasing annealing times at a given temperature. (Diss. Abstr. Int., B)

23351 MECHANISM OF DISLOCATION MAXIMA OF INTERNAL FRICTION. Borisov, E. V.; Vedenyapin, G. A. Fiz.-Khim. Mekh. Mater.; 7: No. 3, 96-9(1971). (In Russian).

An expression for the relaxation time of internodal atoms was obtained, and the activation energy was calculated for the interaction between them. A model is proposed which suitably describes internal grain-boundary friction, as confirmed by activation energy calculations of the relaxation processes. Theoretical and experimental data are tabulated for 13 metals (including Zr, Mo, Cd, Ti, Nb, and Y) for discussion purposes. (tr-auth)

23352 EFFECT OF LITHIUM VAPOR ON THE CRYSTALLINE STRUCTURE OF W AND Mo. Mel'nikov, M. V.; Larikov, L. N.; Cherepin, V. T.; (and others) (Inst. of Metal Physics, Kiev). Fiz.-Khim. Mekh. Mater.; 7: No. 3, 90-3(1971). (In Russian).

Structural changes in mono- and polycrystalline samples of cast Mo and W were studied after exposure to Li vapor at 1,500°C for 10 to 11 h. Li concentrations in the surface layers of metal were measured by ion bombardment and a mass spectrometer. The Li vapor affected the surface of W samples very little, but penetrated monocrystalline Mo sufficiently to change its fine structure. (K.S.W.)

23353 EFFECT OF LOADING FREQUENCY ON THE FATIGUE STRENGTH OF PURE METALS. Shibarov, V. V.; Shetulov, D. I.; Sokolov, L. D. (Gorky Polytechnic Inst., USSR). Fiz.-Khim. Mekh. Mater.; 7: No. 3, 29-32(1971). (In Russian).

The effects of loading frequency of metals strength and failure were studied at 20°C for the following high-purity metals: La, Cd, Bi, Ga, and In. Application of a load to 2-mm diameter specimens was repeated at the rate of 2, 60, 1600, 2800, 6000, and 14,000 times/min. Fatigue deterioration was evaluated by structure changes (Cd and Bi) through electrocorrosion and microphotography. Increased frequency of loading raised the fatigue strength of Cd and Bi; and the lower the amplitude of loading the greater the effect of frequency. In the case of La, Ga, and In, diverse results were obtained; raising the frequency lowered the fatigue strength of La, but raised those of Ga and In. These phenomena are in part explained in terms of the homologous temperature, i.e., the ratio of the experimental temperature (293°K) to the melting point of the given metal (°K). (K.S.W.)

23354 INVESTIGATION OF THE STRUCTURE AND CERTAIN PROPERTIES OF ALLOYS BASED ON THE MOLYBDENUM–RHENIUM SYSTEM. Pikunov, M. V.; Danilina, T. B.; Mel'nikova, L. V.; Desipri, A. I. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 22-8(1971). (In Russian).

The metallographic structure of a Mo–Re alloy produced in an arc furnace with a nonconsumable electrode was studied in detail. A method of preparation of sections and etching conditions were developed for this purpose. It was demonstrated that this alloy, depending on the conditions of heat treatment, may be either a one- or a two-phase alloy with the corresponding changes in properties. Physical heterogeneity of ingots was detected, related to the conditions of solidification and manifested as sharp differences in dendritic structure. This heterogeneity caused differences in hardness in various sectors of the ingot. The possibility of deformation of the alloy by hot pressing and impact upsetting was also studied. (JPRS)

23355 PHOSPHIDES, SULFIDES, AND OTHER ACTINIDE FUEL COMPOUNDS AS POSSIBLE CERAMIC FUEL MATERIALS. Handwerk, J. H.; Kruger, O. L. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 17: No. 3, 397-408(1971).

The preparation and fabrication of actinide compounds in the pnictide and chalcogenide classes are discussed. These compounds have potential as nuclear fuels for certain types of nuclear reactors. The properties of these compounds which would be of interest for nuclear applications were measured and reported. These properties were found to be dependent on the purity of the compound, and to some extent on the method of fabrication. (auth)

23356 NIZKOTEMPERATURNAYA RENTGENOGRAFIYA METALLOV. (Low-Temperature Radiography of Metals). Finkel, V. A. Moscow; Izdatel'stvo Metallurgiya (1971). 256p.

Low-temperature x-ray techniques for studying the crystallographic structure of metals are described. The application of these techniques has been successfully used in studying polymorphic conversions of metals, thermal expansion, and electron effects in metal structure. The bulk of the text deals with the crystalline structure at low temperatures of all known elements, and in particular of magnetic materials, superconductive metals and compounds, and isotopic effects in connection with the structure of metals. Among the superconducting metals and compounds of particular interest are Ta, V, α-U, γ-U, α-Zr, Mo, Nb, and Re, Nb_3Sb, V_3RH, Mo_3Al, Zr_3Au, and V_3Si. 249 references. (K.S.W.)

23357 COMPARISON OF QUANTITATIVE ANALYSES MADE WITH ENERGY AND WAVELENGTH DISPERSIVE ANALYZERS OF BULK AND EXTRACTED PARTICLES OF $ZrCr_2$. Sabol, George P.; Spengler, Charles J. (Westinghouse Research Labs.,

Pittsburgh). Prakt. Metallog.; 9: No. 1, 15-20(Jan 1972). (In English and German).

Results obtained on comparable specimens of bulk material and extracted particles of $ZrCr_2$ using wavelength dispersive electron beam microanalyzer (WD-EMA) and energy dispersive scanning electron microscope (ED-SEM) analysis are compared. Analyses with the ED-SEM system were made at different take-off angles by changing the tilt of the specimen stage. The effect of stage tilt was determined for the pure metals and bulk $ZrCr_2$ at tilts between 5 and 80° and for the $ZrCr_2$ particles at tilt angles of 30, 40, and 50°. Out of the x-ray intensities the k-values were determined and normalized so that they totaled 1.00 weight fraction ($k_{Zr} + k_{Cr} + k_{Fe} = 1.00$). The normalized k-values for the particles determined at 40 and 50° tilt with the ED-SEM system bracket the comparable k-values determined with the WD-EMA system. (auth)

23358 EXAMINING COMPOSITE MATERIALS WITH THE SCANNING ELECTRON MICROSCOPE. Davis, L. W.; Long, J. R. (Harvey Aluminum, Inc., Torrance, Calif.). Metals Eng. Quart.; 12: No. 1, 38-41(Feb 1972).

The advantages of using the scanning electron microscope (SEM) for examining filamentary composites are discussed. A composite consists of a reinforcing fiber incorporated in a metallic or organic matrix. In either system, hardnesses of the fiber and matrix usually differ greatly. This has caused difficulty in the preparation of specimens for metallographic examination. The depth of focus possible with the SEM makes it possible to obtain sharp, clearly defined micrographs of specimens that have appreciable differences in surface level. This depth of focus is also invaluable in the examination of uneven fracture surfaces. Several well-defined micrographs, produced by the SEM, of filamentary composite specimens are given and discussed. (T.F.D.)

23359 PLATE-WELDING OF PIPING IN REACTOR ENGINEERING. Dueren, C.; Muesch, H.; Bruehl, F. Mannesmann Forschungsber.; No. 551, 1-12(1971). (In German).

The submerged arc-welding band procedure offers an economic method of providing seamless tubes of a diameter >350 mm with an inner plating. For the production of tube bends, half shells are also plated by means of band electrodes, and connected through longitudinal seams. The demands for intergranular corrosion resistance as well as crack resistance, and for a smooth plated surface can be met by using particular bands and powders and by controlling welding conditions. Annealing at temperatures of 600°C for the purpose of tension reduction does not affect the mechanical and technological properties of welded plates with ferrite contents between 4 and 10%. There are various possible methods for the joint welding of the plated tubes and tube bends, depending on the accessability of the seams. (INIS)

23360 HIGH-TEMPERATURE CREEP AND LONG-TIME STRENGTH OF THE NIOBIUM ALLOY 5VMTs. Krivenyuk, V. V.; Tsvilyuk, I. S.; Pyl'nikov, V. I. (Inst. of Strength Problems, Kiev). Prob. Procnosti; No. 6, 54-9(1971). (In Russian).

In spite of the extensive use of niobium-based alloys, little information is contained in the literature concerning the characteristics of their creep and long-time strength. The results of the tests described in the present article, on alloy 5VMTs (W–5.08 %, Mo–2.2 %, Zr–0.7 %, O–0.021 %, C–0.01 %, N–0.008 %) in the temperature range from 1,000 to 1,800°C on the basis of 0.1 to 1,000 hours, in conjunction with results from similar tests on alloy VN-2, make it possible to expand somewhat the framework of phenomenological analysis of the particularities of the creep and long-time strength characteristics of niobium-based alloys. (JPRS)

23361 PROPERTIES OF WELDED JOINTS OF ALUMINUM–BERYLLIUM ALLOY. Komarov, M. A.; Gitarskii, L. S.; Lobzhanidze, A. V.; Smetannikov, V. V. Svar. Proizv.; No. 9, 26-8(Sep 1971). (In Russian).

Properties of welded joints of No 1, No 2, Be-31Al, Be-41Al, and Be-38Al Al–Be-alloys (0.8 to 3.0 mm thick sheets) welded by the argon-arc and electron beam methods, were experimentally investigated. The results are discussed by reference to graphs showing the phase diagram of Al–Be and the effects of welding rate on mechanical properties of argon-arc welded joints of 2.0-mm-thick sheets and their microstructures. The experiments demonstrated that high quality welds on sheets of Al–Be alloys can be obtained by dc argon-arc welding of direct polarity in a chamber with controllable atmosphere. A redistribution of the Be-component in the thermal influence zone and the seam metal takes place, influenced by the Al–Be welding thermal cycle. The strength of Ar-arc welded joints was found to be 34 kg/mm^2; their plasticity and ductility characteristics exceeded the characteristics of the initial metal. In order to obtain a quality weld by the electron-beam method, the welding must be performed in two operations (with a sharp beam and with a defocused beam), but the properties of such joints are lower than the properties obtained by Ar-arc welding. (JPRS)

23362 PHASE COMPOSITION OF WELDS, ALLOYED WITH HOLMIUM, IN IRON–ALUMINUM ALLOYS. Ryabov, V. R. Automat. Weld. (USSR) (Engl. Transl.); 24: No. 7, 75-6(Jul 1971). Translated from Avtomat. Svarka; 24: No. 7, 76-7(Jul 1971).

X-ray structural, and in some cases microscopic (visual) analyses were made of alloys prepared from Ho–Al–Fe by melting the metals in a purified argon atmosphere in an arc furnace. The alloys were annealed for 2100 h at 500°C and were then quenched in cold water. The results showed that there are seven ternary phases in the Al–Fe–Ho system region studied. Four of these are ternary compounds and the remaining three are solid solutions based on binary compounds. It was concluded that there is no doubt that some particular amount of the phase (the compound $HoFe_{4\to5.3}Al_{8\to6.7}$) is formed in all Fe–Al welds alloyed with Ho, and that it affects their strength. (P.C.H.)

23363 RECENT PROGRESS IN BERYLLIUM TECHNOLOGY. Hayes, Earl T. Metalurgia (Sao Paulo); 26: No. 155, 767-70 (Oct 1970). (In Portuguese).

The use of Be in aircraft brakes, automatic pilot systems, and aerospace vehicles and missiles is discussed, as well as the reasons for the choice of Be for these applications. Properties of the metal, problems of its fabrication, and reasons for its relatively high cost are reviewed. (Metals Abstr.)

23364 INVESTIGATION OF THE INFLUENCE OF ADMIXTURES OF CARBON AND ZIRCONIUM CARBIDE ON THE COLD BRITTLENESS OF CAST MOLYBDENUM. Belous, O. A.; Danilovtseva, O. G.; Kuznetsova, V. A.; (and others) (Inst. of Metallophysics, Kiev). Probl. Prochnosti; No. 6, 97-101(1971). (In Russian).

An investigation was made on the influence of carbon and zirconium carbide upon the structure of cast molybdenum alloys, and of the relationship of the structure to the temperature of transition to a brittle state. It was found that even for alloys which have a complex structural state, the rules governing the change of the cold-brittleness temperature may be explained if account is taken of the composition of the solid solution, its structural state, and the nature of the formation of excess phases on the grain boundaries. (JPRS)

23365 VERSATILE HIGH-TEMPERATURE ALLOY. Herchenroeder, Robert B.; Matthews, Steve J.; Tackett, Joseph W.; Wlodek, Stanley T. (Cabot Corp., Kokomo, Ind.). Metal Progr.; 101: No. 3, 60-1; 64(Mar 1972).

Haynes alloy No. 188 features a combination of high strength, formability, weldability, and oxidation resistance. Many jet engine, aerospace, nuclear, and chemical process applications are foreseen. It's available in a range of forms. As a sheet material, for example, it can be applied in the burner and afterburner sections of advanced jet engines. (auth)

23366 SELECTING PLATE STEELS FOR NUCLEAR STEAM SUPPLY SYSTEMS. Sterne, Robert H. Jr.; Gorman, William H. Jr.; Brooks, Robert L. (Lukens Steel Co., Coatesville, Pa.). Metal Progr.; 101: No. 3, 71-2; 74-7(Mar 1972).

Carbon, alloy, and clad steel plates play vital roles in the construction of nuclear powerplants. Applications include heavy-wall reactor vessels, steam generators, pressurizers, containment structures, heat exchangers, and piping. (auth)

23367 FILLER METALS RESIST RADIATION DAMAGE. Grant, Samuel P. (Babcock and Wilcox Co., Lynchburg, Va.); Fortner, Edward. Metal Progr.; 101: No. 3, 82-3(Mar 1972).

The application of low-alloy steels in nuclear reactor vessels with the attendant benefits of thinner walls, lighter weight, greater safety, and fabrication and transportation economies has been held back by a lack of weld metals with sufficient resistance to radiation damage. The low-copper, low-phosphorus compositions described below may clear the path. (auth)

23368 COMPRESSIVE CREEP BEHAVIOR OF A Pu–1 wt% Ga δ-STABILIZED ALLOY AT ELEVATED TEMPERATURES. Lytton, J. L. (Virginia Polytechnical Inst. and State Univ., Blacksburg); Wheeler, A. D.; Thayer, W. L.; Robbins, J. L. Met. Trans.; 3: No. 3, 659-66(Mar 1972).

Constant stress compression creep tests were performed in vacuum on a high-purity Pu–1 wt% Ga δ-stabilized alloy over the temperature range from 252 to 382°C for stresses from 700 to 2500 psi. Although the primary creep behavior could not be correlated by established techniques, the creep rates developed after true creep strains of about 0.15 provided good agreement with the temperature and stress dependence of creep for pure metals and dilute alloys. A power stress law for steady-state creep of the alloy was found for σ/E values less than 5×10^{-4}, with the stress exponent being 4.0, and it was concluded that the

alloy exhibits Class I solid solution behavior. For higher stress, exponential stress dependence was observed. The true activation energy for creep was found to be 38,900 cal per mole which is in good agreement with the value for self-diffusion of plutonium in the δ-stabilized alloy. The primary creep behavior could be divided into three types: at low strain rates, the creep rate gradually increases to a nearly steady-state; at intermediate strain rates, the creep rate first decreases and then increases to steady-state; and at high strain rates, the creep rate decreases gradually to steady-state. It was concluded that the failure of established creep correlations for primary creep of Pu–1 wt % Ga was the result of some temperature-dependent component of creep structure, possibly resulting from radiation damage by α particles. (auth)

23369 HYDROGEN ABSORPTION BY STEELS AND ITS INFLUENCE ON THE PLASTIC PROPERTIES. Gerasimov, V. V.; Lipanina, A. A.; Margulova, T. Kh. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 2, 109-11(Feb 1971).

Translated from Teploenergetika; 18: No. 2, 72-4(Feb 1971).

The susceptibility to saturation by hydrogen was investigated for pearlitic steels; the effects of hydrogen absorption on the mechanical properties and on the structure of the steel were studied, and also the state of the crystal lattice of specimens saturated with hydrogen. The results showed that in the initial state all the pearlitic steels contained the same amount of hydrogen (up to 1.5 cm^3/100 g of metal), while after electrolytic hydrogen absorption or testing in autoclaves the hydrogen contents differed in the different pearlitic steels. The least susceptible to hydrogen was casing steel. The highest hydrogen content was observed in 15CRMo steel. Plastic deformation (to 15%) decreased hydrogen absorption by the steels. The results showed that to minimize the possibility of hydrogen embrittlement, heat treatment is mandatory (to revive cold hardening). (P.C.H.)

23370 AUTORADIOGRAPHIC OBSERVATIONS ON GRAIN-BOUNDARY PROCESSES. Bartha, L.; Kozma, L. (MTA Mueszaki Fizikai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 12, 582-7(Dec 1971). (In Hungarian).

The detection of grain-boundary diffusion of ^{204}Tl in tin by autoradiography is examined. Calculation of the diffusion coefficient by means of the Le Claire method using an equidensitogram is described. Observation of the grain-boundary diffusion phenomenon is explained in the case of self-diffusion in sintered tungsten samples. (auth)

23371 MAGNESIUM–ZIRCONIUM ALLOYS: AN EVOLUTION OF PROPERTIES. Guinee, W. F. Rev. Soc. Roy. Belge Ing. Ind.; No. 4, 178-84(Apr 1971).

The development of Mg–Zr alloys is traced from formulation of the original Z5Z aircraft material and the subsequent rare-earth and Th containing ZRE1 and ZT1 compositions. Factors leading to the particularly good castability of the ZRE1 alloy and the logical further development of Zn- or Ag-containing RZ5, ZE63, and MSR compositions are discussed. In effect three groups comprising: materials with high strength up to 160°C; those with good strength and creep properties at 250 to 350°C; and the Ag-containing alloys, which retain their strength up to 250°C, are available. Applications of alloys in each of the groups are described and illustrated, and design nomograms of anticipated corrosion rates and protective measures required are presented. (Metals Abstr.)

23372 FEATURES OF CAVITATION FRACTURE IN REFRACTORY METALS AND ALLOYS. Bofachev, I. N.; Veksler, Yu. G.; Karasyuk, Yu. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 6, 111-16(1971). (In Russian).

Refractory metals with a bcc lattice and alloys based on these metals are used extensively in the manufacture of pipelines and pump parts for the transfer of molten metal coolants in nuclear power engineering. A study was made of the features of deformation and fracture of refractory metals and refractory metal-based alloys under conditions of cavitation-erosion action. It was found that for one and the same refractory metal with a bcc lattice the cavitation resistance and nature of fracture, kinetics, and depth of strengthening the surface layer depend on the condition of the metal (cast of powder metal). The character and magnitude of this difference depends on the nature of the metal as well as the size and distribution of micropores in the powder-metal material. The relatively high cavitation resistance of tungsten has been linked with its high strength properties. For an alloy of molybdenum with 47% Re the combination of high initial strength and hardness with intensive strengthening in the initial period of testing gives it a significantly higher resistance in comparison with tungsten. For powdered molybdenum and especially tungsten, the primary start of fracture at the grain boundaries was characteristic. In the case of a significant magnitude of micropores (powder-metal niobium), nucleation fractures are involved. For cast molybdenum and niobium a significant plastic deformation of the surface preceded failure. In contrast to molybdenum, primary fracture of the grain boundaries was not observed in niobium. (JPRS)

23373 EXTENSION OF SOLID SOLUBILITY DURING MASSIVE TRANSFORMATIONS. Massalski, T. B.; Perkins, A. J.; Jaklovsky, J. (Carnegie-Mellon Univ., Pittsburgh). Met. Trans.; 3: No. 3, 687-94(Mar 1972).

Recent studies of massive transformations in systems based on copper or silver have shown that the degree to which the primary solid solution, α, may be extended into the two-phase field, (α + β), during a composition invariant massive transformation, varies from system to system, and depends upon a number of factors. A systematic study of this point was performed in the Cu–Zn, Cu–Al, and Ag–Cd systems, using quenching and heating techniques. In each system a series of alloys, increasing by small intervals (0.1 at. %) of solute content, was examined. Particular care was taken in the control of composition and homogeneity of these alloys. The results showed that the highest solute content for which the massively-formed phase can be identified metallographically exceeds the equilibrium α-phase boundary value by about 0.45 and 1.2 at. % in the Cu–Zn and Cu–Al systems, respectively, and by several atomic percent in the Ag–Cd system. In the latter case, extension of solid solubility into the two-phase region occurred both from the fcc α and the hcp ζ equilibrium phase fields. It is suggested that these findings may be interpreted in terms of local nonequilibrium conditions at the massive transformation interface. (auth)

23374 VELOCITY INDEPENDENT DRAG DURING GRAIN BOUNDARY MIGRATION. Grey, E. A.; Higgins, G. T. (Univ. of Liverpool). Scr. Met.; 6: No. 3, 253-8(Mar 1972).

Studies on the grain boundary migration in 99.9999 atom % Cd using the Sun and Bauer bicrystal technique and normal grain growth revealed the existence of a velocity independent drag. The observation of the velocity independent drag and its importance in the analysis of migration data is discussed. It was concluded that the concept of a limiting grain diameter in high purity materials is at variance with, and represents a significant departure from, the conventional power law ($D \propto t^n$) employed by most to interpret grain growth data. Ignoring this type of drag effect has led to erroneous interpretation of grain growth, particularly regarding arguments concerning the grain growth exponent and the existence of two stage growth kinetics. (P.C.H.)

23375 STRUCTURAL TRANSFORMATIONS IN SOME ALLOYS OF THE Ti–Zr–O SYSTEM. Dechamps, Michel; Dubertret, Alain; Lehr, Pierre (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France. Centre d'Etudes de Chimie Metallurgique, Paris). Compt. Rend., Ser. C; 273: No. 25, 1725-8(20 Dec 1971). (In French).

Alloys in the Ti–Zr–O system have different structures depending upon their compositions and the thermal treatments to which they have been subjected. X-ray crystallographic analysis of these alloys enabled the hcp α phase and the bcc β phase of the equilibrium diagram to be identified. Furthermore, it was possible to identify an already known hexagonal ω_0 phase, and in addition, an unknown orthorhombic ω'_0 phase having the following parameters: a = 4.839 A, b = 8.148 A and c = 6.104 A. (France)

23376 PLASTIC DEFORMATION OF Ti AND Zr. Brehm, Claude (Compagnie Generale d'Electricite, Marcoussis, France); Lehr, Pierre. Metaux (Corros.-Ind.); 46: No. 553, 325-34(Sep 1971). (In French).

The tensile strength curves of Ti monocrystals deforming by prismatic slip were analyzed. The effects of temperature and stressing rate on the deformation were studied simultaneously. The variations in the activation volume and the activation enthalpy with temperature indicate that a single thermally activated process controls the kinetics of the deformation in the 77 to 473°K temperature range, interactions between mobile dislocations and impurities being the essential mechanism. (France)

23377 THERMAL DIFFUSION IN LIQUID METALS. Gallina, V.; Omini, M. (Politecnico, Turin). Nuovo Cim.; 8B: No. 1, 65-89(11 Mar 1972).

The problem of thermal diffusion in liquids is treated in the context of a phenomenological theory, where the subject of diffusion in liquids is reconsidered. A general formula for the enrichment factor is obtained in terms of four characteristic parameters of the liquid; the average drift velocities of the particles under the action of a thermal gradient are also required. An attempt is also made to define the nature of the force moving the atoms through the liquid when the thermal gradient is established. Arguments are given to retain as a good approximation of this force the simple expression $F = -k_B \nabla T$. By using a modified Stokes relation between force and drift velocities, a good agree-

ment between theory and experiment was found for the case of an isotopic mixture. (auth)

23378 RESISTANCE TO WEAKENING AFTER HEATING OF COPPER ALLOYS FOR CONDUCTORS. Berent, V. Ya.; Bushe, N. A.; Portselan, A. A. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 359-61(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; No. 5, 12-14(May 1971).

Studies were made on the effects of the degree of cold deformation and heating time and temperature on Cu alloyed with Mg, Cd, Zr, Cr, and Ag. For both Cu and Cu alloys an increase in deformation from 17 to 99.5% resulted in a continuous increase in strength and reduction in plasticity. The strength increased most for Cu–M, followed by Cu–Cd and Cu–Ag. The strengthening was lowest with alloying additions insoluble or only slightly soluble in Cu. After prolonged holding at 350°C, the strength resulting from cold deformation was highest for the Cu–Zr bronzes, although the weakening of the Zr and Cr bronzes with increasing holding time was substantial at this temperature. The bronzes containing Ag and Cd were completely recrystallized under these conditions. There was a substantial decline in the strength of the Cu–Mg alloys. (P.C.H.)

23379 DIFFUSION IN THE SYSTEM Nb–Sn. Ronami, G. N.; Gryzunov, V. I.; Baranov, I. A.; (and others) (Moscow State Univ.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1322-4(Sep 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 9, 1490-3(Sep 1971).

Using local x-ray spectral analysis of diffusion pairs, the phase diagram and kinetics of layer formation in the system Nb–Sn were investigated. The "diffusion" diagram, which differs from diagrams constructed by other methods by its lower temperature boundary of the region of existence of the β-phase (800°C) and by the presence of an inflection at 1350°C at the boundary of the regions of the β/α phases, was constructed. This marked change in the region of homogeneity of the β-phase coincided with the approximate boundary corresponding to the kinetic laws of formation of layers of the β-phase (Nb_3Sn): above this temperature, formation was represented by diffusion laws $D = 0.022 \exp\{(-55{,}400 \pm 7800)/RT\}$ (cm^2/sec); below 1350°C the process did not fit within the framework of the diffusion mechanism. The results are discussed. (auth)

23380 SOLIDIFICATION MODE OF WELD METAL IN INCONEL 718. Yoshimura, H.; Winterton, K. (Dept. of Energy, Mines, and Resources, Ottawa). Weld. J. (N. Y.); 51: No. 3, 132s-7s(Mar 1972).

The solidification mode of weld metal in Inconel 718 has been investigated by means of optical microscopy, especially using the etch-pit technique, transmission electron microscopy, and electron-microprobe analysis. It was found that the weld metal shows bands with dark edges, these bands being normal to the direction of solidification. There are two kinds of relationships between the dendritic structure and this banding: one involves the growth of dendrites through the banding, and the other the nucleation and growth of new dendrites when the old dendrite enters a new band. Using the etch-pit technique, many etch pits were observed at the dark edges of the bands because of the high dislocation density there. According to the results of electron-microprobe analysis, there was some microsegregation at the dark edges of the bands showing that the iron, nickel, manganese, and chromium contents decreased and the molybdenum, titanium, and niobium contents increased. The occurrence of banding is a direct indication of variation in the growth rate of solidification in weld metal. (auth)

23381 HIGH-TEMPERATURE-STRENGTH, PRECIPITATION-HARDENABLE, AUSTENITIC, IRON-BASE ALLOYS. Robertshaw, Fred C.; Bartos, Jon L.; Hurst, James J.; McGurty, James August (to United States Atomic Energy Commission). U. S. Patent 3,640,704. 8 Feb 1972. Filed 20 Jan 1970.

Description is given of an iron-base alloy system characterized by the fact that it consists of an iron–nickel–chromium matrix which maintains substantially complete austenitic stability at temperatures from room temperature to the melting point and is susceptible to treatment to effect a precipitation-hardening resulting in a molybdenum-containing precipitated phase. The alloy consists essentially of, in atom percent, 20 to 30 percent nickel, 5 to 10 percent chromium, a strength-inducing additive selected from either molybdenum or tungsten in an amount not exceeding 10 percent, and the balance iron. (Official Gazette)

23382 ACOUSTIC EMISSION CHARACTERISTICS OF HEAT TREAT CRACKING IN RENE 41 WELDMENTS. D'Annessa, A. T.; Owens, J. S. (Lockheed-Georgia Co., Marietta). Weld. J. (N. Y.); 51: No. 3, 156s-8s(Mar 1972).

The characterization of post-weld heat treat cracking in René 41 weldments—a well-known problem often encountered with complex and/or highly restrained superalloy weldments—is discussed with special consideration as to when and how heat-treat cracking occurs in René 41. To accomplish this, an acoustic emission technique was developed for in-situ monitoring of crack-susceptibility test specimens during heat treatment. Accordingly, several test parameters were established which were found to be capable of discriminating characteristics of the cracking process, thus making it possible to study subcritical and gross cracking events. Acoustic emission data were used to screen the effects of welding process and pre-weld base metal processing variables on cracking behavior, and to provide a means for correlating the relative crack susceptibility of differing microstructures. (auth)

Radiation Effects

Refer also to abstracts 24656 and 24671–24672.

23383 (ANL–7883) SIMULATION OF IN-REACTOR CREEP OF TYPE 304 STAINLESS STEEL. Harkness, S. D.; Yaggee, F. L.; Nolfi, F. V. Jr. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 14p. Dep. NTIS.

A method that uses 22-MeV-deuteron bombardment to simulate in-reactor creep conditions is described. Initial results on Type 304 stainless steel demonstrated that the creation of large numbers of Frenkel pairs by bombardment produces creep rates at least 50 times greater than the thermal values. A 40°C variation in test temperature from 330 to 370°C did not significantly change the creep rate measured during deuteron bombardment. A comparison of creep rates obtained from a sample containing the void-dislocation loop microstructure typical of fast-reactor irradiations with a sample containing no previous irradiation damage indicated that a much lower creep rate must be expected when voids and dislocation loops are present. (auth)

23384 (COO–3171-3) BUBBLE FORMATION IN HELIUM ION IRRADIATED GOLD FILMS. Brown, R. D.; Rao, P.; Ho, P. S. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 7 Jan 1972. Contract AT(11-1)-3171. 27p. Dep. NTIS.

Both polycrystalline and single crystal gold films of about 2000 Å thickness were irradiated to a dose of 10^{14} ions/cm^2 (≡80 ppM helium) with 40 keV He^+ ions. The specimens were examined using transmission electron microscopy to identify the defects present and correlate their annealing behavior with the stages of bubble formation. Three such stages were observed. The first was the appearance of dislocation tangles in the as-irradiated specimen. The second stage occurred during annealing at about 300°C when both dislocation loops and vacancy clusters were observed. The density of dislocation loops decreased with increasing annealing time at 300°C, while the vacancy cluster density remained nearly constant. At the beginning of the third stage, a 400°C anneal removed all the dislocation loops while the vacancy clusters remained, though with decreased density. Upon further annealing at this temperature the vacancy clusters vanished and bubbles formed. The annealing behavior of the bubbles was studied, together with the effect of vacancy clusters and dislocation loops on bubble formation. The effects of surfaces and grain boundaries on bubble formation were determined by comparing the annealing temperatures for bubble formation in single crystal and polycrystalline specimens. (auth)

23385 (DP–1273) IRRADIATION GROWTH OF EBR-II FUEL PINS. Sturcken, E. F.; Wicks, G. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec 1971. Contract AT(07-2)-1. 33p. Dep. NTIS.

Preferred orientation studies of centrifugally-bonded EBR-II fuel pins showed that the pins have a [110], [001] axial texture, which is responsible for their shortening in length and diametrical growth during irradiation. The growth indexes calculated from texture data correlate well with observed irradiation growth and give a single crystal growth rate, g, of 200% per % burnup, which is in the range measured for other uranium alloys. Texture gradient studies showed that the texture forms during centrifugal bonding as a stress-relieving mechanism for the $\gamma \rightarrow \alpha$ transformation. (auth)

23386 (HEDL–TME–71-181) SOME IMPLICATIONS OF THE COMPUTER SIMULATION OF DISPLACEMENT CASCADES IN RADIATION DAMAGE MODELING. Doran, D. G. (Hanford Engineering Development Lab., Richland, Wash.). Dec 1971. Contract AT(45-1)-2170. 27p. Dep. NTIS.

Implications of computer simulation studies of displacement cascades are discussed. The referenced studies are the cascade simulations carried out by Beeler and subsequent short-term annealing simulations carried out at HEDL. Estimates obtained

with different models are given for the production rates of displacements and of free and clustered defects in EBR-II and FTR core spectra at low fluences. (auth)

23387 (HEDL-TME-71-189) DAMAGE FUNCTIONS FOR DETERMINING IRRADIATION EFFECTIVENESS. Simons, R. L. (Hanford Engineering Development Lab., Richland, Wash.). Nov 1971. Contract AT(45-1)-2170. 20p. Dep. NTIS.

A method is described for determining irradiation effectiveness of different neutron spectra in causing radiation damage to fuel cladding and reactor structural materials. The method involves definition of a semi-empirical damage function using measured data from specimens irradiated in thermal and fast test reactor spectra. The damage function is applied to design problems involving irradiation effects to reactor structural and fuel cladding materials to predict the fluence which would produce a specific damage level. The current status of damage functions for different material properties is presented. (auth)

23388 (IS-2620) IMPURITY-DEFECT INTERACTIONS AND RADIATION HARDENING IN BCC METALS. Wechsler, Monroe S. (Ames Lab., Iowa). [1971]. 10p. (CONF-710905-4). Dep. NTIS.

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971).

A review of research on radiation hardening in bcc metals is presented. It is noted that mechanisms of radiation-anneal hardening are not firmly established. It is felt that interstitial impurities migrate to defect clusters and strengthen them as barriers to dislocation motion. This suppresses dislocation channeling for radiation-anneal-hardened materials. (J.R.D.)

23389 (IS-2687) FUNDAMENTALS OF RADIATION DAMAGE AND APPLICATIONS TO MATERIALS PROBLEMS IN NUCLEAR REACTORS. Wechsler, Monroe S. (Ames Lab., Iowa). [1971]. 7p. (CONF-710917-2). Dep. NTIS.

From Seminar on radiation effects in metals and structural materials; Kyoto, Japan (28 Sep 1971).

Fundamental theoretical and experimental aspects of radiation damage to metals are briefly reviewed, covering such topics as the production of defects upon irradiation, the motion of defects and the annealing of radiation damage, and defect clusters, voids, and bubbles. Applications to materials problems in nuclear reactors are also discussed, and several areas of practical concern are identified for which additional fundamental understanding is greatly needed. (auth)

23390 (IS-2736) DISLOCATION CHANNELING IN IRRADIATED AND QUENCHED METALS. Wechsler, M. S. (Ames Lab., Iowa). [1971]. 43p. (CONF-711047-1). Dep. NTIS.

From Symposium on the inhomogeneity of plastic deformation; Detroit, Mich. (16 Oct 1971).

Dislocation channeling is defined as the process by which slip (or glide) dislocations eliminate defect clusters (black spots and loops) produced upon irradiation or quenching. The slip dislocations tend to become channeled in the defect-free region and severely localized or inhomogeneous deformation occurs. Since dislocation channels are revealed chiefly by transmission electron microscopy (TEM), a review is given of the experimental observations of defect clusters by TEM. Next, a description is presented of the observations and characteristics of dislocation channeling in irradiated and quenched metals. A discussion of the state of understanding of dislocation channeling mechanisms is included. (auth)

23391 (ORNL-TM-3617) OBSERVATIONS ON TUNGSTEN-RHENIUM THERMOCOUPLES USED IN-REACTOR IN $(U,Pu)O_2$ FUEL PINS. Fitts, R. B.; Miller, J. L. Jr.; Long, E. L. Jr. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 16p. Dep. NTIS.

Three W-26% Re sheathed and one molybdenum sheathed, BeO insulated, W-3% Re/W-25% Re thermocouples have been examined. These were used to measure the temperature at the center line of $(U,Pu)O_2$ fuel pins. The thermocouples operated up to 125 h at 2000°C and to 500 h above 1800°C. The only difficulty encountered with the tungsten-rhenium sheathed thermocouples during operation was shorting of one thermocouple to the sheath when the sheath collapsed into a space between two insulators. The structure of the wires and sheaths was examined after irradiation and compared with that produced in out-of-reactor heat treatment. During operation in-reactor, the tungsten-rhenium wires and sheaths developed porosity. This effect was much more pronounced in the W-3% Re wires than in the high rhenium wires or sheaths. Tungsten-rhenium crystals were found deposited on the BeO insulation, and BeO crystals were found on the wall of the W-26% Re sheath. Similar effects were noted in the thermocouple assemblies heated out-of-reactor and more severe attack occurred in the molybdenum-sheathed assembly. The observed structural changes are believed to be the result of vapor phase transport of the components of the thermocouple, probably as volatile oxides. No effect on the thermocouple output was observed. Although the tests were not specifically designed to detect such changes, any calibration shift is felt to have been less than 5% at 2000°C. (auth)

23392 INDUCED GROWTH OF TUNGSTEN IRRADIATED UNDER STRESS AT 20°K. Leteurtre, J.; Pouchou, J. L.; Zuppiroli, L.; (and others) (CEN, Fontenay-aux-Roses, France). Phys. Lett.; 38A: No. 6, 411-12(13 Mar 1972). (In French).

Length and resistivity changes of uniaxially stressed tungsten samples were recorded during irradiation at 20°K by fission fragments. The applied stress polarizes the Burgers vectors of the created dislocation loops. A creep occurs that is actually an induced growth. (auth)

23393 AUTORADIOGRAPHIC OBSERVATIONS ON THE BEHAVIOR OF GAS ATOMS IN NEUTRON IRRADIATED ALUMINUM-LITHIUM ALLOYS. Shiraishi, Kensuke (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 69-76(Feb 1972).

The behavior of radiation-produced gas atoms in Al-Li alloys was observed by means of ^3H autoradiography. The technique is extremely useful for studying the behavior of gas atoms in specimens containing ^3H in concentrations of the order of 10^{-5} in atom fraction. Cold-worked microstructures of the specimen are also revealed in the autoradiographs. However, the effect of β-phase on the behavior cannot be observed by autoradiography. Precipitation of the gas atoms could not be discerned within the grain in specimens irradiated in JRR-2 at ambient-water temperature. Upon heating to 200°C, ^3H was seen to precipitate along the dislocation within the grain and denuded zones free of the precipitate appeared along the grain boundaries. The amount of ^3H remaining in the specimen decreases with rising heating temperature. In the case when the concentration of radiation-produced gas atoms contained is the order of 10^{-5} in atom fraction, gas bubbles are observed in autoradiographs of specimens heated at a temperature as high as 500°C. On the other hand, bubbles are hardly observed in specimens heated at the same temperature when the gas atoms are contained in concentrations of the order of 10^{-4}. Cold-working after irradiation accelerates the migration of gas atoms and the growth of gas bubbles. (auth)

23394 QUESTION OF VOID FORMATION IN NEUTRON IRRADIATED ZIRCONIUM. Wolfenden, A.; Farrell, K. (Oak Ridge National Lab., Tenn.). Scr. Met.; 6: No. 2, 127-30(Feb 1972).

Samples of zone refined Zr were irradiated at 500°C in the ORR. Other samples were irradiated in the HFIR at 150 to 200°C. Examination by transmission electron microscopy revealed no voids in these samples. It is believed that resistance to void formation in these samples is associated with absence of dislocation loop structures and/or low helium content. (J.R.D.)

23395 ZONE FORMATION AND PRECIPITATION IN Cu-Be ALLOYS DURING AGING UNDER IRRADIATION. Yoshida, Hiroyuki; Sagane, Toshimitsu (Kyoto Univ., Osaka). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 1-6(Jan 1972).

The aging characteristics of Cu-Be alloys were studied through measurements of the electrical resistance during neutron irradiation with fluxes of 1.5×10^{11} n_f and 2.3×10^2 $n_{th}/cm^2/sec$ in the temperature range of 100 to 160°C. The resistance of supersaturated specimens increased rapidly during the initial period, reached a maximum (ρ_{max}), and then decreased slowly. During high temperature irradiation the rate of the resistance change was larger for all specimens and the time to reach the ρ_{max} was much shorter than during thermal aging at the same temperature. The reason is that the Guinier-Preston zone formation and the precipitation of γ' phases in Cu-Be alloys is accelerated markedly by irradiation. Based on experimental activation energies for the process, the acceleration mechanism is discussed. (auth)

23396 EFFECTS OF TEMPERATURE AND IMPURITIES ON ELECTRON RADIATION DAMAGE IN THE HIGH VOLTAGE MICROSCOPE. Spring, M. S.; Ipohorski, M.; Goringe, M. J. (Cavendish Lab., Cambridge, Eng.). Radiat. Eff.; 11: No. 3-4, 251-9(Dec 1971).

The results of irradiation of specimens of copper and copper containing up to 2 at. % beryllium in the high-voltage electron microscope are described, at 20 to 500°K, and discussed in the light of recently proposed theories of defect nucleation. Although the results were difficult to interpret because of the many diverse factors which influence the nucleation and growth of the damage, it was found that the values for the volume density of defects were in general agreement with the predictions, if the effects of the foil surfaces were taken into account. The corrected densities were used to derive values for the activation energy for motion of an interstitial in copper, E_m, and for the binding energy between an

interstitial and a beryllium atom, E_b. The results obtained were 0.12 ± 0.03 eV for E_m and 0.29 ± 0.07 eV for E_b. (auth)

23397 IRRADIATION CREEP ASSOCIATED WITH DISLOCATION CLIMB. Dollins, C. C. (Bettis Atomic Power Lab., Pittsburgh). Radiat. Eff.; 11: No. 3-4, 123-31(Dec 1971).

It is believed that creep in materials containing a dispersed second phase may be controlled by the climb of edge dislocations around the second phase. This model is proposed to be applicable to neutron irradiated materials containing Seeger zones. It is assumed that edge dislocations are pinned by the zones and can escape by climbing out of the zones by absorption of neutron produced point defects, the dissolution of the zones by absorption of neutron produced interstitials, the dissolution of the zones by vacancy emission from the zones and thermally activated cutting of the zones by the dislocations. The above four mechanisms are incorporated into a set of equations similar to those originally proposed by Seeger for hardening in neutron irradiated copper. The effects of temperature, neutron flux, fluence, and applied stress are considered. (auth)

23398 NUCLEATION OF VOIDS IN IRRADIATED METALS. II. THE GENERAL CASE. Russell, Kenneth C. (Massachusetts Inst. of Tech, Cambridge). Scr. Met.; 6: No. 3, 209-14(Mar 1972).

An attempt was made to calculate the co-precipitation rate of vacancies, interstitials, and gas atoms into voids, thus modeling processes occurring in the fast breeder reactor. In the co-precipitation of vacancies and interstitials, the existence of a pseudo-equilibrium distribution permitted the rate to be expressed in a form very similar to the usual nucleation equations; however, the presence of gas atoms creates severe problems. It was found that if a pseudo-equilibrium distribution is to exist, it must bear a particular functional relationship to the equilibrium distribution which obtains in the absence of excess interstitials. It is generally thought that gas atoms are present in substitutional sites; in this case the constraints are so severe that it is generally impossible to define a pseudo-equilibrium distribution. The constraints are not as severe for the less-likely case of interstitial gas atoms, but even so, the free energy of void formation must have a special functional form. A difference equation is presented that describes void nucleation in the breeder environment; it is believed that a theoretical understanding of void formation in the breeder reactor will come from solution of this equation. Accordingly, a numerical evaluation for the steady-state nucleation rate and incubation time is under study. (auth)

23399 VOID NUCLEATION DURING ELECTRON IRRADIATION. Makin, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 25: No. 3, 761-7(Mar 1972).

The absence of void formation in pure nickel during electron irradiation at high temperatures, unless gas atoms have previously been injected, has been interpreted as evidence that gas atoms are required to nucleate voids. Experiments have shown, however, that voids can be formed at high temperatures in undoped nickel subjected to a previous electron irradiation at low temperatures. The effect is believed to be due to the very low dislocation density which is stable in thin foils of pure metals irradiated at high temperatures, due to the slip of dislocations to the surfaces. The primary function of the gas injection is hence to raise the dislocation friction stress. Surface dislocation loss has a critical effect only in pure low critical shear stress materials, and has no effect on high voltage electron microscope irradiations of technologically important materials. (auth)

23400 INTERNAL FRICTION IN Al SUBJECTED TO WORK HARDENING AND IRRADIATION. Brissaud, M. (Centre National de la Recherche Scientifique, Meudon, France); Lucasson, P. Mem. Sci. Rev. Met.; 68: No. 11, 793-9(Nov 1971). (In French).

Variations in the internal friction of a single Al crystal subjected to a uniaxial deformation and/or radiation were studied at a frequency of 21MHz. Isothermal or linear annealings followed the treatments. The results obtained are interpreted in terms of the lattice defects formed, which are responsible for the changes. In particular, the isotherms obtained at 230 and 250°K appear to result from the superposition of two processes occurring at very different rates: the rearrangement of dislocations and the migration of point defects toward them. (France)

Other Materials

Refer also to abstracts 23225 and 24666.

23401 (DLR-FB-67-49) INFLUENCE OF LONG-TIME HEATING ON NONHIGH-TEMPERATURE METAL ADHESIVES AND METAL-BONDED JOINTS. Althof, W. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugzeugbau). Jul 1967. 43p. (In German). Dep. NTIS (U. S. Sales Only).

The influence of long-time heating on the bond strength of metal-bonded joints with non-high-temperature adhesives was investigated. Also, torsion-pendulum tests with adhesive substances were made to find an explanation for the change of bond strength due to long time heating. (auth)

23402 CATALYTIC OXIDATION OF CARBON. Turkdogan, E. T.; Vinters, J. V. (United States Steel Corp. Research Center, Monroeville, Pa.). Carbon; 10: No. 1, 97-111(Feb 1972).

The rate of oxidation of iron-impregnated electrode graphite granules (<0.01 to 2.1% Fe) in CO_2–CO mixtures was measured at temperatures 700 to 1000°C and at pressures 0.03 to 1.0 atm. Some measurements were made also with iron-impregnated coconut charcoal and coke. In air oxidation experiments, graphite granules impregnated with silver, copper, chromium, zinc, nickel, cobalt, and iron were used. The rate of oxidation in CO_2–CO mixtures increased by several orders of magnitude when graphite was impregnated with iron, e.g. with 2.1% Fe-graphite the rate in CO_2 was a factor of about one million greater than that for iron-free graphite. At 800°C, the rate increased almost linearly with the iron content. After 20 to 50% oxidation the catalytic effect of iron diminished even in gas mixtures where iron could not be oxidized. However, upon H_2 treatment the catalytic effect could be revived. The dependence of the rate on gas composition suggests that there might be strong CO_2 and CO adsorption on the pore walls of graphite impregnated with iron and that for a given total pressure the rate of oxidation in CO_2–CO mixtures is proportional to the partial pressure of CO_2, i.e., the rate of oxidation is controlled by the dissociation of CO_2 with an apparent heat of activation of 87.6 kcal. (auth) (UK)

23403 DEFORMATION OF GRAPHITE AT HIGH PRESSURES. Paterson, M. S.; Edmond, J. M. (Australian National Univ., Canberra). Carbon; 10: No. 1, 29-34(Feb 1972).

In high pressure experiments, it was found that the compression stress–strain curve of a porous polycrystalline graphite depends markedly on the confining pressure in the range 1 to 8 kb and that considerable volume changes occur during the deformation as well as during application of the pressure. There is also an almost complete recovery of both length and volume during release of the pressure after strains of up to 20%. After allowing for the interaction with the stress–strain behavior of the work associated with volume changes, it was concluded that, in addition to basal slip, frictional sliding on internal surfaces is an important mechanism of deformation, especially at the lower pressures, and that the deformation is accompanied by some process such as flexure of platelets which introduces the internal stresses responsible for the recovery effects. (auth)

23404 TENSILE AND CREEP BEHAVIOR OF POLYCRYSTALLINE GRAPHITES. Dergunov, N. N.; Krotov, A. I.; Barabanov, V. N.; Anufriev, U. P. (Trest Soyuzelectrod, Moscow). Carbon; 10: No. 1, 19-27(Feb 1972).

Tensile strength and ductility were measured on commercial grade graphites with different grain sizes. Creep behavior was analyzed by the following equation: $\epsilon = B \log t + ct$. The data were measured by the unispecimen method. The samples annealed after creep gave the same creep curve at the secondary loading as at the first one. The parameter of strain hardening was found for the description of step creep curves. The parameters B and C were determined as functions of stress and temperature. (auth) (UK)

23405 EFFECT OF NUCLEAR IRRADIATION ON THE INTERNAL FRICTION AND DYNAMIC ELASTIC MODULUS OF STRESS-GRAPHITIZED PYROLYTIC CARBON. Blankenhorn, P. R.; Kline, D. E. (Pennsylvania State Univ., University Park). Carbon; 10: No. 1, 51-7(Feb 1972).

The effects of room temperature irradiation on the dynamic elastic modulus, E', and the internal friction, Q^{-1}, of graphite were investigated over the range ~10^{12} to 10^{19} nvt, (>50 keV). Well-ordered graphite formed by stress-annealing pyrolytic carbon at high temperatures was used in the experiments. Tests were conducted at audio frequencies in the temperature range from 100 to 650°K. Modulus values increased with dose at all test temperatures. Irradiation to 1.4×10^{19} nvt resulted in a modulus increase by a factor of ×8 in the 100°–400°K range. An inverse-annealing peak, present near 500°K at lower doses, became largely masked at higher doses (1.4×10^{19} nvt). Results also indicated that the threshold for detection of radioinduced changes was surprisingly low (≤10^{12} nvt). This corresponds to a fractional displacement of ~10^{-8} atoms/atom. Accompanying changes in the internal friction for various doses are presented and discussed. Results for a ^{60}Co irradiated specimen are also presented to illustrate that gamma radiation (140 Mrad) produces clearly detectable changes in E'. The overall research indicates that models for radiation damage in graphite may have to be altered to account for the effects. (auth) (UK)

23406 EXTREMELY LOW SURFACE FRICTION INDUCED BY INTENSE RADIATION. Dukhovskoi, E. A.; Ponomarev, A. N.; Silin, A. A. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 1, 75-8(1 Sep 1971). (In Russian).

Surfaces of MoS_2 (rhomboid structure), graphite, and polyethylene were bombarded at room temperature with 2-keV helium ions (10^{13} ions cm^{-1} sec^{-1}). The coefficient of friction dropped to 0.0015 (the limit of sensitivity of the test equipment) during bombardment but recovered its original value from 350 to 500 sec after irradiation ceased. The phenomenon could be repeated many times. A mechanism for these effects is proposed. (K.S.W.)

23407 YOUNG'S MODULUS AND INTERNAL FRICTION OF GRAPHITE IRRADIATED AT LOW TEMPERATURE. Bonjour, E.; (CENG, Grenoble, France); Le Diouron, R.; Fiorese, G.; Rouby, D.; Gobin, P. F. Radiat. Eff.; 11: No. 3-4, 155-65(Dec 1971).

Samples of pyrolytic graphite and nuclear graphite were irradiated at 27 or 77°K with neutrons and electrons. The dynamic Young's modulus was studied by an isochronal annealing method, and the internal friction was measured as a function of temperature. The modulus changes with irradiation dose and annealings were interpreted using a model based on the pinning of basal dislocations by interstitial atoms. The anneals revealed an additional effect which was attributed to bonds between interstitial defects and atoms in the adjacent graphite layers. The observed modulus annealing stages were consistent with results of others. The internal friction data obtained after low temperature irradiation compared with those following room temperature irradiation. Three internal friction peaks were again observed with activation energies of 0.24, 0.28, and 0.9 eV, and interpreted by relaxation processes of interstitial defects. Another peak, at room temperature, was analyzed in terms of interaction between dislocations and point defects. (auth) (UK)

23408 THERMAL EXPANSION COEFFICIENTS OF GRAPHITE CRYSTALS. Morgan, W. C. (Battelle-Northwest, Richland, Wash.). Carbon; 10: No. 1, 73-9(Feb 1972).

Graphite crystal expansions were derived as a function of temperature using the theoretical relationships of Riley; the resultant equations provide reasonable fits to the measured lattice expansion data over the temperature range 300 to 3000°K. (auth)

23409 CONTINUOUS ELECTRON MICROSCOPIC OBSERVATION OF CARBONACEOUS DEPOSITS FORMED ON GRAPHITE AND SILICA SURFACES. Baker, R. T. K.; Feates, F. S.; Harris, P. S. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 10: No. 1, 93-6(Feb 1972).

The depositing characteristics of various gas mixtures containing CO_2, CO, and CH_4 were observed by controlled atmosphere electron microscopy and the initiation processes established. A flocculent amorphous deposit only formed in the presence of iron particles at temperatures above 900°K. Iron can be deliberately introduced or formed from carbonyl impurities in the CO or by diffusion from iron-bearing surfaces. Radiation contributes to the formation of this type of deposit. At temperatures above 1175°K plate-like growths developed about iron particles in contact with a graphite substrate, which were believed to be recrystallized graphite. Mechanisms are suggested for the formation of these deposits. (auth)

23410 EFFECT OF RADIATION DOSE ON THE RADIATION CREEP OF POLYMERS. Stepanov, V. F.; Vaisberg, S. E.; Karpov, V. L. (Physical-Chemical Inst., Moscow). Fiz.-Khim. Mekh. Mater.; 7: No. 4, 78-83(1971). (In Russian).

Radiation creep of polymers was investigated as a function of the radiation dose. Deformation curves were obtained from samples of teflon, poly(methyl methacrylate), kapron (a kind of nylon) and styroflex before and after sufficient mR of radiation to achieve a change in the deformation characteristics of the polymer. Analysis of the data showed that radiation creep of polymers is not determined by the radiation dose, although sometimes the latter is a contributing factor. (K.S.W.)

23411 ACCELERATION OF DIFFUSION OF CADMIUM AND MERCURY IN HgTe UNDER THE EFFECT OF GAMMA IRRADIATION. Zaitov, F. A.; Alekseev, N. V.; Popovyan, G. E. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1440-1(Sep 1971).

Translated from Izv. Akad. Nauk SSSR. Neorg. Mater.; 7: No. 9, 1624(Sep 1971).

Studies were made on the effects of γ radiation on diffusion of Cd and Hg in HgTe monocrystals. The results showed a marked increase in the rates of diffusion of the components and impurities in HgTe by γ irradiation. It is speculated that the complex and time-consuming procedure of thermal homogenization annealing that is usually used to improve the homogeneity of single crystals of the solid solutions CdTe–HgTe might be to some extent replaced by radiation-stimulated ordering of the material. (P.C.H.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 23268 and 25034.

23412 (HEDL-TME-71-122) PLUTONIUM DIOXIDE FEED MATERIALS HANDLING AND MEASUREMENT STANDARDS STUDIES. FY-71 Summary Report. Smith, F. M. (Hanford Engineering Development Lab., Richland, Wash.). Dec 1971. Contract AT(45-1)-2170. 27p. Dep. NTIS.

Work in the plutonium dioxide feed materials handling and measurements standards program consisted of evaluation of HEDL plutonium assay capabilities, comparison of HEDL plutonium measurements results with those of other laboratories, review of prior analytical chemistry exchange programs, and evaluation of methods for improvement of plutonium assay techniques. (auth)

23413 (KFK-1105) APPLICATION OF CRITERIA IN A SAFEGUARDS SYSTEM. Avenhaus, R.; Gupta, D.; Kraemer, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Apr 1971. 25p. Dep. NTIS (U. S. Sales Only).

One of the important aspects of systems analytical investigations in connection with safeguards is the quantification of safeguards terms and relations. A method which can be used to apply criteria in a quantifiable manner for the reduction of maximum routine inspection efforts by the IAEA is examined. These maximum efforts for different categories of nuclear facilities and the criteria used to establish the routine inspection efforts for such facilities are laid down in the articles 80 and 81 of the Document INFCIRC/153 published by the IAEA. The method developed is based on a point allocation system with weight factors which are in common use in other decision making processes. The use of this method is illustrated using hypothetical examples. (auth)

23414 GUIDE TO PRACTICE NUCLEAR MATERIAL CONTROL SYSTEM FOR NUCLEAR POWER REACTORS. New York; American National Standards Institute (1970). 11p.

A standard is presented which establishes requirements for the control of special nuclear material in the facilities of nuclear power reactors where such material is used in the production of electrical energy. The materials involved in such a facility are uranium and plutonium of various isotopic content. The nuclear material control system involves the establishing of receipts from the shipper, three internal material balance areas, and records of shipments to a reprocessor as the means of maintaining control and accountability of all leased or owned special nuclear materials. (auth)

23415 METHOD AND APPARATUS FOR THE NONDESTRUCTIVE ASSAY OF BULK NUCLEAR REACTOR FUEL USING 1 keV TO MeV RANGE NEUTRONS. Untermyer, Samuel (to National Nuclear Corp.) U. S. Patent 3,636,353. 18 Jan 1972. Filed 13 May 1968.

Neutrons having energies confined to a range above thermal and below fast are used to interrogate bulk reactor fuel. Prompt and delayed neutron counting of the reaction products is used to obtain an assay of the valuable fissionable species content of the fuel. (Official Gazette)

Disposal and Storage

Refer also to abstract 22792.

23416 (BNWL-B-148) CRITICAL REVIEW OF BIOLOGICAL ACCUMULATION, DISCRIMINATION, AND UPTAKE OF RADIONUCLIDES IMPORTANT TO WASTE MANAGEMENT PRACTICES, 1943-1971. Price, K. R. (Battelle Pacific Northwest Labs., Richland, Wash.). Dec 1971. Contract AT(45-1)-1830. 67p. Dep. NTIS.

Results of a survey to screen the world literature for data on biological uptake and accumulation or the discrimination against uptake of certain radionuclides associated with nuclear waste management are presented. Historical aspects based on the publication sequence of biological research are briefly considered, and relevant research findings are discussed under several categories. One category is devoted to transuranic elements and is accompanied by a special bibliography. The application of research findings to the Hanford situation is discussed and projects for future study are recommended. An annotated list of 119 references is presented. (auth)

23417 (KFK-1454) FINAL STORAGE OF RADIOACTIVE WASTE. ANNUAL REPORT, 1970. Diefenbacher, W.; Heil, H.; Krause, H.; Schuchardt, M. C.; Albrecht, E.; Kolditz, H.; Thielemann, K.; Borchert, H.; Duerr, K.; Klarr, K.; Kuehn, K.; Staupendahl, G. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany). Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Munich (West Germany)). Sep 1971. 52p. (In German). (GSF-T-34). Dep. NTIS (U. S. Sales Only).

A survey of work performed in 1970 in the field of disposal of radioactive wastes is presented. The mining and construction work carried out both underground and above ground at the Asse salt mine near Remlingen is discussed. Measures were taken for maintenance and repair and for expansion of operation in accordance with the future purposes of the facility. The storage of low-level radioactive wastes at the 750 m level was continued in the period under review. The major components of the facility for trial storage of intermediate level wastes were assembled in the salt mine at the 490 m level. For shipment of intermediate level wastes across the country another shielded container of the E 2 type was developed which can be used for wastes with a radiation dose rate of up to 10^5 rem/h. Also, the state of research in the fields of rock mechanics, geology, hydrology, and its results and on plans for new techniques of storage are also discussed. (auth)

23418 FIXATION OF ^{192}Ir ON NATURAL SORBENTS IN A BITUMINOUS VESSEL. Daiev, Kh.; Delchev, G.; Gradev, G.; Simov, S.; Zhelyazkov, V. (Inst. of Physics, Sofia). At. Energ. (USSR); 32: No. 1, 87-9(Jan 1972). (In Russian).

In a simulation of radioactive waste treatment, the sorption of ^{192}Ir on zeolite and vermiculite and the subsequent fixation with bitumen of the resulting sorbed products were studied. The initial Ir solution was prepared by dissolving $(NH_4)_3IrCl_6$ in water to yield a specific activity of 2,040 cts/min·ml. Layers of vermiculite and zeolite were placed in a bituminous vessel, and then allowed to contact solutions of $AgNO_3$ and ^{192}Ir (0.001 Ci). After a water wash the sorbed mixture was dried, and molten bitumen was used to seal the vessel. No leached-out activity could be detected after months of exposure of the assembly to rain and snow under the open sky. (K.S.W.)

23419 REPORT OF THE GOVERNMENTAL STUDY COMMITTEE OF RADIOACTIVE SOLID WASTE MANAGEMENT. Genshiryoku Shiryo; No. 42, 1-44(Aug 1971). (In Japanese).

The management of radioactive solid waste in Japan is presented in view of estimation of the radioactive waste produced in the future and classification of radioactivity levels. Technical problems of final disposal are discussed with respect to safety criteria and environmental survey after the disposal. Techniques of transport and abandonment accompanying the final disposal are presented. Systematic management of the radioactive waste disposal is discussed and a few examples of systems are given with composition of the systems. Finally, research and development in the final disposal of radioactive wastes and better disposal methods in Japan are considered as future subjects. (Japan)

23420 CRITICALITY PROBLEMS OF ACTINIDE ELEMENTS. Clayton, E. D.; Bierman, S. R. (Battelle-Northwest, Richland, Wash.). Actinides Lanthanides Rev.; 1: No. 5, 409-32(Sep 1971).

Considerable data now exist for criticality control guidance on $^{233}_{92}U$, $^{235}_{92}U$, and $^{239}_{94}Pu$. Potential requirements for other actinide elements could now lead to production in significant quantities when measured against the amounts that could result in criticality. Thus, it is appropriate to consider the criticality aspects of other fissile and fissionable isotopes in view of current and future production in addition to the three specific isotopes above. Nuclides such as $^{237}_{93}Np$, $^{238}_{94}Pu$, $^{240}_{94}Pu$, $^{241}_{95}Am$, and $^{244}_{96}Cm$ contain even numbers of neutrons and are all fissionable. The nuclides $^{241}_{94}Pu$, $^{242m}_{95}Am$, $^{243}_{96}Cm$, $^{245}_{96}Cm$, $^{247}_{96}Cm$, $^{249}_{98}Cf$, and $^{251}_{98}Cf$ all contain odd numbers of neutrons and each is highly fissile. In considering the criticality of the even-N nuclides it is noted that the optimum condition for criticality in terms of mass is reversed. It is reversed in the sense that mixing moderator to a material (such as $^{237}_{93}Np$) renders criticality impossible, whereas adding the appropriate amount of moderator to a fissile nuclide (such as $^{239}_{94}Pu$) produces the condition resulting in the smallest critical mass. For the even-N nuclides, moderation is found to prevent, rather than enhance, criticality. Small critical mass values have been reported for some of the highly fissile odd-N nuclides; to illustrate, the critical mass for $^{251}_{98}Cf$ in spherical geometry in an aqueous solution at optimum moderation was calculated to be only 10 g. To obtain data for criticality control guidance, in the absence of direct experimental criticality data, it is necessary

to proceed on the basis of calculations with the cross section data available. Data are presented on criticality, and the factors affecting criticality, with emphasis on 12 of the actinide isotopes for which few, or no, direct criticality data exist; calculations are used in the absence of such data. In addition, although some nuclides are not fissile and cannot be made critical in a moderated system, these nuclides may be accompanied during their production with highly fissile isotopes. All those isotopes composing the mixture must then be carefully considered for criticality control. Criticality problems of mixtures of fissile and fissionable isotopes also are discussed. (auth)

23421 CONTAINERS FOR RADIOACTIVE MATERIALS. Bochard, Camille (to Robatel SLPI). British Patent 1,265,290. 1 Mar 1972. Filed 2 Feb 1971.

A container is described which is designed to give more efficient heat dissipation. It comprises an inner wall of radioactive shielding material provided with a number of cooling projections, and an outer wall spaced from the inner wall to form a jacket through which coolant fluid can be passed. The outer wall is formed of two or more releasable panels, secured to the inner wall by jointing members arranged to release the panels when the temperature reaches a predetermined level. Air is a suitable coolant and the jacket may be connected with a fan. Spring means may be provided to eject the panels from the outer wall, and the jointing members may comprise a material that melts at the predetermined temperature level. (UK)

Handling Equipment and Procedures

Refer also to abstract 23429.

23422 (TID–5415) PRECISION CRANE. NYX Test Numbers 2.7.1, 2.7.2, 2.7.3, 2.7.4, 2.7.5. Harshbarger, C. K. (Du Pont de Nemours (E.I.) and Co., Wilmington, Del. Atomic Energy Div.). May 1953. Contract AT(07-2)-1. 69p. (DPXN–231). Dep. NTIS.

Declassified 9 Oct 1971.

The precision crane for charging and discharging reactor components was one of the major Savannah River 100-Area auxiliaries installed and tested at NYX. Tests covered functional performance and positional accuracy of the crane and its control equipment. A limited evaluation of the reliability of the crane was made. The results and conclusions of NYX Crane tests are presented. Suggestions are made for a further test program which seems necessary at the Savannah River Plant. (auth)

23423 HANDLING OF RADIOACTIVE ^{133}Xe DISSOLVED IN SALINE. Abdel-Dayem, Hussein Mahmoud (Veterans Administration Hospital, Buffalo). J. Nucl. Med.; 13: No. 3, 231(Mar 1972).

A simple technique for the storage and dispensing of ^{133}Xe in saline solution which has proven to be free from the difficulties of loss and diffusion is described. Regardless of how the ^{133}Xe is supplied, the solution is transferred into a tight, sterile, glass syringe of a suitable volume. Any bubbles that form in the syringe during the transfer are removed in the usual manner, and the storage syringe is closed by means of a sterile, disposable, three-way stopcock. The shielded glass syringe can be stored up to 5 days at low temperature with no danger of leakage. (P.C.H.)

23424 NUCLEAR FUEL TRANSFER MACHINE. Crate, John J. (to Combustion Engineering, Inc.). U. S. Patent 3,637,096. 25 Dec 1971. Filed 27 Feb 1969.

A machine for transferring fuel bundles from a reactor-handling pool to the spent fuel-handling pool through a tube in the reactor containment wall is described. A load-supporting carriage including its own driving means operates to move horizontally along support rails from the reactor pool to the spent fuel pool. A fuel carrier adapted to receive the fuel elements is pivotally mounted on the load supporting carriage with its vertical orientation established by interaction between guide rollers mounted on the fuel carrier and guide rails. These guide rails are arranged so that the fuel carrier is in a vertical upright position in each of the pools while it is guided to a horizontal position for transfer through the transfer tube. (Official Gazette)

23425 SEALED JOINING SLEEVE. Mansard, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,064,489. 28 Jun 1971. Filed 16 Sep 1969. (In French).

A sealed sleeve joining two hollow cylinders, containing a fluid, is described. It is intended for installations analyzing irradiated samples. The first cylinder corresponds to the pipe-line bringing in the reprocessing fluid; its diameter is well defined. The second cylinder serves as a variable diameter irradiation capsule and contains the irradiated sample. The sleeve consists of a conventional type self-closing female joint, fixed at one end to a cylindrical ferrule, an intermediate ring consisting of two elastic annuli with appropriate diameters, and a spacing washer. A laterally pierced bolt is provided with holes for screws, which block and compress the assembly. (France)

23426 ESTIMATION OF TEMPERATURE TRANSIENTS DURING THE HANDLING OF SPENT NUCLEAR FUEL BUNDLES. Carver, M. B.; Atfield, M. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 21–6 of Spent Nuclear Fuel Heat Transfer: Fuel Casks and Transfer Operations. /Groetch, D. J. (ed.). New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

Typical questions concerning the handling of spent fuel are: How soon after removal from the reactor can the fuel be removed from water storage and handled in air without sheath temperatures exceeding handling safety limits? What temperature will the sheath attain if a bundle becomes dry at any time during transfer from reactor to storage bays? The application of a package of computer programs designed to answer such questions is described. The programs are general in nature, so that any type of fuel bundle may be studied, and are in two groups. The first group generates the geometrical data necessary for heat transfer calculations within a bundle. The second group reads in a particular bundle irradiation history and conditions at the start of a transient and computes the transient temperature response of all elements within the bundle. Computed temperature curves are presented for typical cases, and the computed results show good agreement with actual measurements. (auth)

Transportation

Refer also to abstract 22759.

23427 (70-CNA-644) TRANSPORTATION OF RADIOACTIVE MATERIAL: PROGRESS AND POTENTIAL. Blackburn, R. W. (Atomic Energy Control Board, Ottawa (Ontario)). [1971]. 16p. (CONF-700564–22). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association, Toronto, Canada (24 May 1970).

The bases for the IAEA Regulations for the Safe Transport of Radioactive Materials and the organization and regulations of the Canadian modal regulatory authorities are introduced. Regulatory progress in the transportation of radioactive materials was examined as well as its effects on the Canadian nuclear program. Potential improvements in the transportation of radioactive materials are also described. (auth)

23428 (GKSS–71/E/3) SHIELDED CONTAINER FOR INTERNAL TRANSPORT IN THE GEESTHACHT REACTOR STATION. Borchers, F.; Fries, S.; Petersen, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m,b,H., Hamburg (West Germany)). 1971. 12p. (In German). (CONF-710448–1). Dep. NTIS (U. S. Sales Only).

From twelfth session of the study group for operations and safety questions in reactor research; Munich, Germany (29 Apr 1971).

Described and depicted in several diagrams are two transport containers for highly active fuel elements and loop inserts. The containers are used for transportation between reactors and hot cells. (tr-auth)

23429 SPENT NUCLEAR FUEL HEAT TRANSFER: FUEL CASKS AND TRANSFER OPERATIONS. Winter Annual Meeting of The American Society of Mechanical Engineers, Washington, D. C., December 1, 1971. Groetch, D. J.; Todreas, N. (eds.). HTD-VOL. 2. New York; American Society of Mechanical Engineers (1971). 44p. $6.00. (CONF-711207).

Seven papers are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual papers see: 23426, 23430–23434, and 24794.

23430 GENERAL SPENT FUEL CASK SITUATION...NOW... AND THE FUTURE. Blunden, D. J. (Whitehead and Kales, Detroit). pp 1-2 of Spent Nuclear Fuel Heat Transfer: Fuel Casks and Transfer Operations. /Groetch, D. J. (ed.). New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

The current status of the spent fuel shipping cask is discussed in relation to design and demand. The future trends and needs in the shipping cask industry are also discussed. (T.F.D.)

23431 GENERAL CASK DESIGN AND DESIGN GROUND RULES. Langhaar, J. W. (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). pp 3-9 of Spent Nuclear Fuel Heat Transfer: Fuel Casks and Transfer Operations. /Groetch, D. J. (ed.). New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

The principal regulatory requirements affecting the design of casks for irradiated fuel are described. The economics of different designs and methods of meeting the requirements are discussed in general terms, with emphasis on the particularly troublesome areas of structural integrity and thermal behavior. (auth)

23432 RELATIONSHIPS BETWEEN HEAT TRANSFER AND THE MECHANICAL AND SHIELDING DESIGN REQUIREMENTS OF SPENT FUEL SHIPPING CASKS. Jennings, John L. Jr. (NL Industries, Inc., Wilmington, Del.). pp 10-16 of Spent Nuclear Fuel Heat Transfer: Fuel Casks Transfer Operations. /Groetch, D. J. New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

Every element of the design of shipping casks for power reactor fuel is heavily influenced by heat transfer considerations, most particularly in the cases of loss of coolant and fire accidents. Any change in shielding or structural design must be evaluated in terms of its effect on heat transfer. Only through close coordination at every stage of design can a cask be produced which is economical as well as licensable. Some of the conflicts which must be overcome and some solutions which are practical within the present state of the art are discussed. (auth)

23433 THERMAL ANALYSIS OF A SPENT FUEL SHIPPING CASK FOR HTGR FUEL. Hinz, R. F. (Gulf General Atomic Co., San Diego, Calif.). pp 17-20 of Spent Nuclear Fuel Heat Transfer: Fuel Casks and Transfer Operations. /Groetch, D. J. (ed.). New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

The Fort St. Vrain High Temperature Gas-Cooled Reactor (HTGR) spent fuel shipping cask, which is intended for commercial transport operations, was licensed in November 1970. The thermal design and analysis for this cask was done using a production version of the two-dimensional heat transfer program RAT. The RAT code calculates steady-state and transient temperature distributions based on a finite-difference formulation of the heat conduction problem. The input of geometric and thermal data to this code is considerably easier than with codes such as THTD or CINDA. This ease of input enabled a rapid and accurate thermal analysis of the Fort St. Vrain fuel shipping cask. Without modification to the basic program, modeling techniques were adequate to simulate solar heating, fire accident, external radiation, and free convection conditions outside of the cask. Radiation across internal gaps and gap changes due to thermal expansion of the materials were also readily modeled. (auth)

23434 THERMAL DESIGN OF SPENT FUEL SHIPPING CONTAINERS TO SURVIVE THE HYPOTHETICAL FIRE ACCIDENT. Serkiz, Aleck W. (Battelle Memorial Inst., Columbus, Ohio). pp 36-44 of Spent Nuclear Fuel Heat Transfer: Fuel Casks and Transfer Operations. /Groetch, D. J. (ed.). New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

Fire survival requirements impose various constraints on nuclear material shipping container designs. The result has been, in many cases, a bulky package which is difficult to handle, load or unload, and quite susceptible to environmental conditions. Casks which must ship spent fuel assemblies having a high level of decay heat are presently considered to be a major design problem. However, the small casks (which often have a negligible amount of decay heat) must also survive the fire environment and not lose their shielding capability as specified by the AEC-DML regulations. Design techniques which have been evolved at Battelle–Columbus over the past 14 years which utilize various cask components (such as fins) in a dual capacity, and present calculated thermal responses of these cask systems when they are subjected to the hypothetical fire specified in the AEC 10-CFR-Part 71 regulations are described. Also contained are several comparisons of analytics with experiment. (auth)

23435 IMPACT OF THE PROPOSED REVISIONS TO IAEA REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Seagren, R. D. Nucl. Safety; 13: No. 2, 103-6 (Mar-Apr 1972).

An effort is under way to revise and update the IAEA Regulations for the Safe Transport of Radioactive Materials. Under the new regulations the present system of classifying radioactive material into groups according to the radiotoxicity of the radionuclide concerned will be discontinued. Instead, assessments of the likely intake of radioactive material after serious damage for packaging are combined with calculated radiation doses for unit intake of some 280 radionuclides to derive a theoretical safe limit for the radioactive content of transport packages. Activity release rates for packaging under normal conditions of transport as well as under accident conditions are to be based on these safe limits. (auth)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 24281 and 24726.

23436 (AECL-3911, pp 67-74) ACCELERATOR RESEARCH AND ENGINEERING. Tunnicliffe, P. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

Engineering problems in the design of a 3-MeV, 100-mA Alvarez proton accelerator and a 4-MeV, 15-mA electron linac at Chalk River are briefly discussed. (W.H.K.)

23437 (KFK-EXT-3/71-9) PHYSICAL AND ECONOMIC FACTORS WHICH WILL AFFECT THE DESIGN OF THE EUROPEAN SUPERCONDUCTING SYNCHROTRON. Green, Michael A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Sep 1971. 13p. Dep. NTIS (U. S. Sales Only).

The construction of the CERN II Synchrotron as either totally or partly superconducting will take place only if it is economically justified. Many of the machine design parameters will be determined by the conventional synchrotron which will be built first. Within this framework, economic considerations will play a dominant role in determining the parameters of the superconducting machine. This report discusses four options which one can take for building a superconducting synchrotron at CERN. Machine parameters are discussed in terms of economics. Optimization of field, aperture, and cycle time are discussed. A list of basic machine parameters and probable component parameters is presented. (1 table, 16 references) (auth)

23438 (KFK-EXT-3/71-11) COMPARISON OF SINGLE AND DUAL RING SUPERCONDUCTING SYNCHROTRONS. Green, Michael A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Sep 1971. 6p. Dep. NTIS (U. S. Sales Only).

This report refutes the notion that a dual-ring superconducting synchrotron is attractive from an economic standpoint. Change of material from today's Nb-Ti materials to an advanced β tungsten material does not alter this conclusion. The dual ring concept only becomes attractive when very short cycle times are considered. Unfortunately, these short cycle times are unattractive for technical and economic reasons. (auth)

23439 POLYERGIC CYCLOTRON. Gordon, Hayden S. (to Secretary of the Air Force). U. S. Patent 3,641,446. 8 Feb 1972. Filed 18 Dec 1969.

A device for the production of a multiple energy proton beam comprising a negative hydrogen ion cyclotron with stripping foils placed at different radial and azimuthal positions is described. The negatively charged hydrogen ions at the various energy levels represented by the radial positions of the foils are stripped of their electrons thereby becoming protons which reverse their direction of curvature because of the reversed polarity and exit from the cyclotron along paths that, with proper azimuthal positioning of the foils, meet at a single point outside the cyclotron. A circular combining magnet centered on this point bends the proton trajectories as required to continue along a common path thus creating the multiple energy or polyergic beam. (auth)

23440 HIGH ENERGY ION ACCELERATOR. Furth, Harold P.; Rosenbluth, Marshall N. (to United States Atomic Energy Commission). U. S. Patent 3,626,305. 7 Dec 1971. Filed 27 Jan 1969.

A static field accelerator for transferring energy from an electron ring to ions confined therein is described; by using static magnetic fields to convert initial electron-ring energy into axially directed kinetic energy the ions are efficiently accelerated to high energies in a short distance. Protons or heavier ions in the range 10 to 100 GeV can be efficiently produced. (7 figures) (R.W.R.)

Auxiliaries and Components

Refer also to abstract 23940.

23441 HIGH POWER VARIABLE WIDTH SLIT SYSTEM. Aringe, L.; Wiedling, T. (Atomic Energy Co., Studsvik, Sweden). Nucl. Instrum. Methods; 98: No. 3, 607-9(1972).

A high power slit system to be used in connection with Van de Graaff accelerators is described. Characteristic of the design is that the slit elements are made of tantalum metal, being cooled with water to be able to withstand high beam power loads. The position of the slit elements can be adjusted with a high degree of accuracy. (auth)

23442 WIDE APERTURE HIGH GAIN BEAM PROFILE SCANNER. Bond, C. D.; Gordon, S. E. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 98: No. 3, 513-23(1972).

A wide aperture high gain X-Y beam profile scanner capable of measuring ion beam intensity distributions up to 10 cm in diameter with a 1mm resolution is described. The system has been used to measure beam current densities from ≈ 5 nA/cm^2 to ≈ 8 μA/cm^2 with output noise levels of ≈ 3 nA peak to peak. Design principles and circuit details are discussed. (auth)

23443 PICOAMPERE CHARGED PARTICLE BEAM MONITOR. Smathers, James B.; Routt, Kenneth R.; Hightower, Dan (Texas A and M Univ., College Station). Rev. Sci. Instrum.; 43: No. 3, 447-50(Mar 1972).

A transmission ion chamber for charged particles was designed to give a continuous indication of beam symmetry and magnitude. Consisting of four separate ion chambers, the signals from opposing chambers were compared to determine beam symmetry and summed to obtain a beam intensity signal. The system is quite simple and offers good linearity at low cost for proton beam currents in the range of 1 to 100 pA. (auth)

23444 ACCELERATOR TUBE ELECTRODE FOR FOCUSING A BEAM OF CHARGED PARTICLES. Enge, Harald A. (to Deltaray Corp.). U. S. Patent 3,629,576. 21 Dec 1971. Filed 21 May 1970.

An electrode for use in an accelerator tube is described; the electrode provides for the focusing of a beam of charged particles within the tube as the particles travel along its length. The electrode has a centrally located aperture and, symmetrically disposed about such aperture, an even number (at least four or more) of indentations, alternately projecting in opposite directions along the axis of the tube. The ideal shape of the electrode can be expressed mathematically as $z = f(r) \cos n\theta$ in a cylindrical coordinate system having coordinates r, θ, and z with the z-axis corresponding to the direction of the tube axis. Here, f(r) is a function which preferably should approximate $f(r) \approx kr^2$, for the region substantially immediately surrounding the aperture and, preferably, up to a radius of twice the aperture radius. (9 figures). (auth)

Ion Sources, Injection, and Extraction

23445 (LBL-223) HEAVY ION DEVELOPMENT AT THE BERKELEY 88-INCH CYCLOTRON. Clark, D. J.; Steyaert, J.; Carneiro, A.; Morris, D. (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971. Contract W-7405-eng-48. 17p. (CONF-711021-11). Dep. NTIS.

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971).

A new internal Penning ion source is now being tested for production of nitrogen and oxygen beams. Nitrogen beams of N^{5+} were accelerated to 250 MeV. An external source for lithium beams is being developed. (7 figures, 1 table) (auth)

23446 MICROSECOND BEAM CHOPPING BY PULSING THE DEFLECTOR VOLTAGE OF THE CYCLOTRON. Rotter, H.; Heiser, C.; Fromm, W. D.; Brinckmann, H. F. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Instrum. Methods; 98: No. 3, 429-32(1972).

The method of cyclotron beam chopping by pulsing the deflector voltage has been established. The system is suitable for half-life measurements in the range from 1 to 100 μsec. The experimental arrangement is described in detail. As a first result the half-life of the three-quasiparticle isomer in ^{177}Ta at 1355 keV has been determined as (5.3 ± 0.5) μsec. (auth)

23447 INJECTION MODE FOR RING CYCLOTRONS. Hagedoorn, H. L. (Eindhoven Univ. of Tech., Netherlands). Nucl. Instrum. Methods; 98: No. 3, 549-52(1972).

It is not always necessary that the revolution frequencies of a ring cyclotron and its injector cyclotron have the same value. For example the following relation between these frequencies may exist: $Nf_{ring} = Mf_{injector}$, where N and M are integers. The

possibility of a low frequency mode of the injector together with a high frequency mode of the ring without decreasing the duty cycle of the final external beam is shown. (auth)

23448 CALCULATED IONIZATION VOLUMES FOR BATCH, CONTINUOUS, AND SELECTIVE EXTRACTION SOURCES OF HEAVY IONS. Darling, R. L.; McShan, D. L.; Davis, R. H. (Florida State Univ., Tallahassee). Rev. Sci. Instrum.; 43: No. 3, 481-8(Mar 1972).

Confinement time and ionization volume calculations have been made for batch, diffusive continuous, and selective extraction types of highly ionized, very heavy atom ion sources. For each source, the results are given for step-by-step only ionization by an energetic electron flux (10^{11} e/cm^3 at 10 keV) and for ionization which includes the Auger effect. These are compared for loss conditions which vary from no loss to a loss cross section 0.05 times that of the $0 \rightarrow 1+$ ionization cross section. For low loss, the ionization volume is least for the selective extraction source, while for a lossy source, the batch process becomes competitive. Volumes for the diffusive continuous source are the largest in all cases. Introduction of the Auger effect reduces the volumes by a factor of 2 to 10 in all but the diffusive continuous source. The ionization volumes required for an output of one particle microampere of Xe^{25+} are calculated for the different types of sources. (auth)

Ion Optics and Field Calculations

23449 INSTABILITY IN THE NUMERICAL CALCULATION OF THE ISOCHRONOUS FIELD OF AN AVF CYCLOTRON. Hagedoorn, H. L. (Eindhoven Univ. of Tech., Netherlands). Nucl. Instrum. Methods; 98: No. 3, 553-5(1972).

In the numerical calculation of the isochronous field of a cyclotron one can encounter an instability problem. This is due to the fact that the revolution frequency and the magnetic field are not exactly linearly coupled. A small variation in the frequency is connected with a small variation in the magnetic induction via an integral operator. The corrections in frequency and magnetic induction are functions of the radius. These functions can be given in a Fourier expansion representation. Using this representation it can be shown that oscillations easily can arise at radii where the mean magnetic induction changes rapidly. Especially near the extraction region one can observe this phenomenon. The period of the oscillations equals roughly two times the oscillation amplitude of the equilibrium orbit. (auth)

23450 INTENSE ELECTRON BEAM DYNAMICS IN A LONGITUDINAL MAGNETIC FIELD. Stallings, C.; Shope, S.; Guillory, J. (Physics International Co., San Leandro, Calif.). Phys. Rev. Lett.; 28: No. 11, 653-5(13 Mar 1972).

An intense relativistic electron beam was propagated in a longitudinal magnetic field with an initial ion density less than 10^9 ions/cm^3 and a neutral density of 10^{16} to 10^{17} ions/cm^3. An optimum pressure and magnetic field were found to exist for efficient beam transport, and these optima were relatively independent of current density. Possible explanations for the loss of beam electrons can be found in the retarding effects of the electric and magnetic self-fields. (auth)

Storage Rings

23451 (LNF-71/82) LONGITUDINAL INSTABILITY DUE TO BEAM-BEAM INTERACTION IN ELECTRON STORAGE RINGS. Amman, F. (Comitato Nazionale per l'Energie Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 30 Nov 1971. 9p. Dep. NTIS (U. S. Sales Only).

The change in the beam orbit length due to an angular perturbation introduces a coupling between transverse and longitudinal motion in a circular accelerator. This effect sets a limit on the maximum transverse density of the beams (and therefore on the luminosity) in a storage ring, that, in particular cases, can be lower than the transverse limit due to the betatron frequency shift; to make full use of the low β insertions additional conditions on the magnetic structure of the ring have to be satisfied. (auth)

Experimental Facilities

Refer also to abstracts 22689 and 24210.

23452 (EURFNR-980) FACILITY FOR THE MEASUREMENT OF FAST NEUTRON FISSION CROSS SECTIONS USING AN INTENSE CYCLOTRON NEUTRON SOURCE. Cierjacks, S.; Kopsch, D.; Nebe, J.; Schmalz, G.; Voss, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Mar 1971. 7p. (KFK-1495; CONF-710301-15). Dep. NTIS (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

From third conference on neutron cross sections and technology; Knoxville, Tenn. (15 Mar 1971).

A facility for the study of fission ratios and fission cross sections in the energy range between 0.5 and 30 MeV is described. For the production of a pulsed neutron beam with a continuous energy spectrum the Karlsruhe isochronous cyclotron is used. The fission fragments are detected by a gas scintillation counter arrangement consisting of nine fission detectors in series. For data acquisition a CDC-3100 on-line computer is used. The principal features and operating characteristics of the facility are described and first results of a measurement on ^{238}U are given. (auth)

23453 (LA-4587) USE OF LAMPF FOR ISOTOPE PRODUCTION. BRIEFING TO THE AEC DIVISION OF ISOTOPES DEVELOPMENT, DECEMBER 15, 1970. Rosen, L.; Schillaci, M. E.; Dropesky, B. J.; O'Brien, H. A. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 35p. Dep. NTIS.

The material in this report is included in four presentations: General introductory remarks concerning LAMPF and its use for isotope production; Comparison of LAMPF and BLIP for producing radioisotopes; Proposed targeting system and LASL hot cell and radiochemistry facilities; and Radionuclides from LAMPF: yields and applications. (32 figures, 10 tables) (R.W.R.)

23454 DEVICE FOR MELTED TARGETS FOR IN-BEAM g-FACTOR DETERMINATIONS. Filevich, A.; Rensfelt, K.-G.; Sztarkier, J. (Research Inst. for Physics, Stockholm). Nucl. Instrum. Methods; 98: No. 3, 601-3(1972).

In order to avoid hyperfine interactions in nuclear magnetic moment measurements, melted targets are often required. A simple arrangement for a suitable target holder and temperature regulator is described. The performance of the device is illustrated by a magnetic moment measurement on a high spin isomer in ^{210}At using the $^{209}Bi(\alpha,3n)^{210}At$ reaction and a melted Bi target. (auth)

23455 FAST MOUNT CLAMP FOR NUCLEAR PHYSICS TARGETS. Lange, A. (Ruhr Univ., Bochum, Ger.). Nucl. Instrum. Methods; 98: No. 3, 605-6(1972).

A small target mount clamp for scattering chambers is described. (auth)

23456 COLLIMATING SYSTEM FOR ELECTRON BEAMS. Lindskoug, Bengt; Dahler, Arne (Univ., Goteborg). Acta Radiol., Ther., Phys., Biol.; 10: No. 4, 454-63(1971).

A new collimating system for electron beams with which extensive measurements including those of induced activity, skin dose and scatter conditions have been performed is described. This appears to constitute a general improvement on the standard cones as regards dose distribution and dose rate, achieved by means of a field defining diaphragm of a special sandwich type. (auth) (Sweden)

23457 INFLUENCE OF SCATTERING FOILS, TRANSMISSION MONITORS, AND COLLIMATING SYSTEM ON THE ABSORBED DOSE DISTRIBUTION FROM 10 TO 35 MeV ELECTRON RADIATION. Svensson, H. (Univ., Umea, Sweden). Acta Radiol., Ther., Phys., Biol.; 10: No. 4, 443-53(1971).

The scattering geometry of the electron beams from a Brown Boveri 35 MeV Asklepitron was studied. The experiments led to modifications of scattering foils, transmission and balancing ionization chambers, and of the collimating system. It was possible to improve the flattening of the treatment fields, to decrease the relative depth doses at small phantom depths, and to increase the absorbed dose rate and the maximum field sizes. Furthermore a better patient set-up accuracy was achieved since the field sizes are simulated by a light field on the patient. (auth) (Sweden)

23458 DOSIMETRIC MEASUREMENTS AT THE NORDIC MEDICAL ACCELERATORS. I. CHARACTERISTICS OF THE RADIATION BEAM. Svensson, H.; Hettinger, G. (Univ., Umea, Sweden). Acta Radiol., Ther., Phys., Biol.; 10: No. 3, 369-84(Jun 1971).

A measuring program was carried out at betatrons and linear accelerators at 11 laboratories in Denmark, Finland, Norway and Sweden. It was shown that simple equipment could be used to determine energy, flattening and source-surface distance in a uniform way with the different accelerators. In order to describe the beam flattening a proposal is given for a homogeneity index. (auth) (Sweden)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

23459 ADVANCES IN ASTRONOMY AND ASTROPHYSICS. VOLUME 7. Kopal, Zdenek (ed.). New York; Academic Press, Inc. (1970). 303p. $18.50.

Separate abstracts were prepared for four of the five articles. The other article, "The Structures of the Terrestrial Planets," by R. A. Lyttleton was not considered in scope for NSA. (W.D.M.)

For abstracts of individual sections see: 23565–23566, 23621, and 23716.

Cosmic Radiation

Refer also to abstracts 22556, 23588, 23796, 23799, and 23901.

23460 (JINR–P2-6225) ACCUMULATION OF COSMOGENIC ISOTOPES IN IRON METEORITES. Barashenkov, V. S.; Sobolevskii, N. M.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The formation rates of cosmogenic isotopes ^{22}Na, ^{36}Cl, ^{40}K, and ^{49}V in iron meteorites were calculated using the Monte Carlo method. The question about variations of cosmic-ray intensities is discussed. Pre-atmospheric radius of the Arus–Yardymlinsky meteorite was estimated. The results were compared with those obtained by other authors. (auth)

23461 STREAMING OF GALACTIC COSMIC RAYS IN THE INTERPLANETARY MAGNETIC FIELD. Hashim, A. (National Research Council of Canada, Ottawa); Bercovitch, M.; Steljes, J. F. Solar Phys.; 22: No. 1, 220-34(Jan 1972).

The correlation between the 24-hr average anisotropy of galactic cosmic rays as measured by a ring of high-latitude neutron monitors and the direction of the 24-hr average interplanetary magnetic field were studied in detail. From the two-year data period 1967–68, events showing instances of marked nonequilibrium anisotropy (i.e. large departures from the average "corotational" anisotropy) were selected. These include trains of spontaneously arising enhanced diurnal variation as well as Forbush decrease events showing large anisotropy in the pre-decrease, main, or recovery phase. It was found that the observed anisotropies were well fitted by the assumption that the streaming of galactic cosmic rays is composed of two components (1) radial streaming away from the Sun with a velocity of ≈400 km/s and (2) diffusive streaming along the direction of the interplanetary magnetic field. The diffusive streaming is mostly towards the Sun. This description is also applicable to periods characteristic of the quiet time diurnal anisotropy. These results are analogous to those obtained by McCracken, Rao, and Ness for 7 to 15-MeV solar-flare particles. (auth)

23462 ACCELERATION OF COSMIC RAYS IN SUPERNOVA REMNANTS. Kulsrud, Russell M. (Princeton Univ., N. J.); Ostriker, Jeremiah P.; Gunn, James E. Phys. Rev. Lett.; 28: No. 10, 636-9(6 Mar 1972).

If the electromagnetic wave theory of pulsars is correct, then particle acceleration occurs within the nebulous debris of the supernova explosion. Model calculations show that each event produces about 10^{49} erg in ionic cosmic rays. Particle energies range from 10^9 to 10^{16} eV (with spectral index ~2 before corrections for losses), and the chemical composition is mostly that of matter processed through several stages of nuclear burning. Both the electronic and the ionic components of the galactic cosmic rays can be maintained by particles accelerated in supernova remnants. (auth)

23463 OBSERVABLE EFFECTS OF THE X-PROCESS MUON SOURCE. Cantrell, W. G. (Texas A and M Univ., College State); Duller, N. M.; Green, P. J.; Wayland, J. R.; Sheldon, W. R. Phys. Rev., D; 5: No. 3, 606-10(1 Feb 1972).

The zenithal enhancements exhibited by calculated integral muon intensities at large zenith angles and high energies are examined for variations due to energy dependence of both the K/π ratio in the conventional meson source of muons and the percentage of X process at production. These enhancements are compared with the Utah underground measurements over a wide range of depth and zenith angle. The indicated energy dependence of the percentage of X process at production is determined, and the implications of the resulting spectra for experimental investigations are discussed. (auth)

23464 PROPAGATION OF MUONS UNDERGROUND AND THE PRIMARY COSMIC-RAY SPECTRUM BELOW 40 TeV. O'Bien, Keran (Atomic Energy Commission, New York). Phys. Rev., D; 5: No. 3, 597-605(1 Feb 1972).

The vertical muon attenuation curve deep underground was analyzed through the medium of a nucleonic cascade model, to yield a primary cosmic-ray nucleon spectrum in the energy region below 40 TeV. Calculations of the angular distribution of muons underground reproduce the Utah experimental results within about 20% without the need to postulate the X process. At these energies it is concluded that the hadron absorption cross section is, to good approximation, constant and geometric, and that the partial inelasticities are also constant. (auth)

23465 MUON CHARGE RATIO AT SEA LEVEL IN THE LOW MOMENTUM REGION. Allkofer, O. C.; Dau, W. D. (Univ., Kiel). Phys. Lett.; 38B: No. 6, 439-40(20 Mar 1972).

The charge ratio in the momentum region 0.3 to 26 GeV/c was determined at two different geomagnetic latitudes with a small spark chamber spectrograph. Both measurements show a maximum in the region around 3 GeV/c. The value of the charge ratio at the maximum amounts to 1.65. There is a hint of this behavior from theoretical calculations. (auth)

23466 RARE GAS STUDIES OF THE GALACTIC COSMIC RAY IRRADIATION HISTORY OF LUNAR ROCKS. Huneke, J. C.; Podosek, F. A.; Burnett, D. S.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta; 36: No. 3, 269-301(Mar 1972).

Analyses of all five noble gases in whole rock samples and mineral separates from lunar rocks in conjunction with available literature data permitted qualitative conclusions concerning average irradiation depths and enabled internally consistent exposure ages for Tranquillity Base rocks to be calculated. Correlated variations in ^{3}He/^{21}Ne and ^{38}Ar/^{21}Ne reflect shielding differences. Diffusion losses cannot explain this correlation, even though evidence for gas loss is obtained from mineral separates data. A qualitative shielding sequence can be constructed which agrees reasonably well with the sequence based on Gd isotopic data. There are no systematic differences between meteoritic and lunar He, Ne, and Ar spallation spectra, with the possible exception of ^{38}Ar/^{21}Ne. Observed variations in meteoritic and lunar Xe spallation spectra, except at mass 131, are due primarily to differences in chemical composition. The relative ^{126}Xe production rates from Ba and rare earths can be derived. Resonance neutron capture on ^{130}Ba is a plausible source for the anomalous ^{131}Xe observed in lunar rocks; the required fluxes are however, quite large. Surface production rates from measurements of radioactive spallation products in lunar samples give more concordant exposure ages than those obtained from meteoritic production rates. This concordance implies that the average irradiation depths for these rocks were small ($\lesssim$150 g/cm^2). Surface production rates for ^{126}Xe and ^{21}Ne yielded exposure ages for fourteen Tranquillity Base rocks which are in reasonable agreement for most rocks. Five low-K rocks yielded exposure ages around 100 m.y. in what may be a significant grouping. At least four major impacts are required to produce the fourteen rocks. (auth)

23467 ORIGINS OF TRAPPED HELIUM, NEON, AND ARGON ISOTOPIC VARIATIONS IN METEORITES. II. CARBONACEOUS METEORITES. Black, David C. (Ames Research Center, Moffett Field, Calif.). Geochim. Cosmochim. Acta; 36: No. 3, 377-94(Mar 1972).

Data are presented from stepwise heating experiments on five carbonaceous chondrites: Alais, Ivuna, Orgueil, Cold Bokkeveld, and Nogoya. The data indicate the presence of two isotopically distinct major trapped components, components A and B. Two additional components, "C" and "E", were isolated on the basis of neon isotopic structure. Components B and C, found in gas-rich meteorites, are attributed to ion implantation by the present-day solar wind and solar flares, respectively. Component A is interpreted as a mixture of component E and component D, where component D is identified with the primitive solar wind and com ponent E is assigned an extrasolar-system origin. (auth)

23468 ORIGINS OF TRAPPED HELIUM, NEON, AND ARGON ISOTOPIC VARIATIONS IN METEORITES. I. GAS-RICH METEORITES, LUNAR SOIL, AND BRECCIA. Black, David C. (Ames Research Center, Moffet Field, Calif.). Geochim. Cosmochim. Acta; 36: No. 3, 347-75(Mar 1972).

Data are presented from stepwise heating experiments and total extractions on five meteorites: Kapoeta, Fayetteville, Holman Island, Cee Vee, and Pultusk. These data reveal the presence of four isotopically distinct trapped neon components. A comparison of trapped neon with trapped helium and argon in bulk analyses indicates the existence of correlated helium,

neon, and argon isotopic structures. Isotopic compositions of the major trapped components in gas-rich meteorites and the lunar fines and breccia are given. (W.D.M.)

23469 AGES AND KINEMATICS OF THE LATE F DWARFS IN RELATION TO THEIR CHEMICAL COMPOSITION. Powell, A. L. T. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.: 155: No. 4, 483-94(1972).

The iron-to-hydrogen ratios, relative to the Sun, of 93 late F field dwarfs within 25 pc of the Sun were determined from their ultraviolet excesses. The ages of these stars were deduced from their positions in the magnitude–colour index diagram. The study shows that the very oldest of these stars is metal-poor and also that there has been significant enrichment of the interstellar medium since the formation of the Galaxy. This agrees with the recent work of Fowler on the exponential galactic nucleosynthesis hypothesis. Those stars with large values of eccentricity and box angle of orbit are also metal-poor and amongst the oldest. (auth)

23470 ORIGIN OF PLANETARY PRIMORDIAL RARE GAS: THE POSSIBLE ROLE OF ADSORPTION. Fanale, F. P.; Cannon, W. A. (California Inst. of Tech., Pasadena). Geochim. Cosmochim. Acta: 36: No. 3, 319-28(Mar 1972).

The degree of physical adsorption of Ne, Ar, Kr, and Xe on pulverized samples of the Allende meteorite at 113°K was measured. The observed pattern of equilibrium enrichment of heavy rare gases over light on the pulverized meteorite surfaces relative to the gas phase was similar to the enrichment pattern (Xe > Kr > Ar ≫ Ne, He) exhibited by "planetary primordial" rare gas when compared with the composition of solar rare gas. Results indicate that, at 113°K, a total nebular pressure of from 10^{-2} to 10^{-3} atm would be required to explain the Ar, Kr, and Xe abundances in carbonaceous chondrites with an adsorption mechanism. This pressure estimate is compatible with the range of possible nebular pressures (10^{-2} to 10^{-6} atm) suggested by astrophysical arguments. However, the subsequent mechanism by which initially adsorbed gas might have been transferred into the interiors of grains cannot be identified at present. The hypothesis that the presence of "planetary primordial" Ar, Kr, and Xe in carbonaceous chondrites is due to their adsorption from the gaseous portion of the pre-planetary cloud is offered as an alternative to the hypothesis that these gases were incorporated as the result of attainment of solubility equilibrium between dust and gas. (auth)

23471 TERRESTRIAL AGE OF NINETEEN STONY METEORITES DERIVED FROM THEIR RADIOCARBON CONTENT. Boeckl, R. (Univ. of California, San Diego). Nature (London): 236: No. 5340, 25-6(3 Mar 1972).

The modes of production of ^{14}C in meteorites are briefly discussed. Although ^{14}C production in rocks on the Earth's surface is negligible, the surface of an object in space is exposed to the full flux of the primary cosmic radiation, and meteorites therefore contain a measurable amount of high-energy spallation products. Meteorites contain very little N and the ^{14}C production is dominated by ^{16}O spallation amounting to about 60 ^{14}C atoms/min/hg. Surface ablation during passage through the atmosphere can account, however, for considerable losses. Some studies are described in which crushed samples of meteorite were mixed with V_2O_5 in a porcelain crucible and subjected to the action of O_2 at 800°C, the evolved CO_2 being collected and converted into C_2H_2. After the C_2H_2 had aged for 3 weeks to allow any ^{222}Rn to decay, it was counted using a proportional counter. Results are tabulated, together with the calculated terrestrial ages. The ^{14}C value of the four falls analyzed averaged 57.3 dpm/hg, a value that demonstrated the 4π irradiation geometry of meteorites in space. The results indicated an average age of the investigated stony meteorites of 5200 yr. (UK)

Stars

Refer also to abstracts 23462, 23533, and 23597.

23472 MONTE CARLO METHOD APPLIED TO RADIATIVE TRANSFER IN COOL STELLAR ATMOSPHERES. Sandford II, Maxwell Tenbrook. Bloomington, Ind.; Indiana Univ. (1971). 224p. University Microfilms Order No. 71-29,589.

Thesis.

The origin of intrinsic polarization in cool stars was investigated theoretically by solving the equation of radiative transfer in the stellar photosphere and a circumstellar envelope of aerosol particles. The limb darkening and center-to-limb variation of the degree of polarization for a cool supergiant star are presented in four colors. Calculations for aerosol scattering in circumstellar envelopes indicate the polarization in the U filter is largely independent of the emergent angle. Magnetic alignment of nonspherical particles may produce the observed intrinsic polarization by creating an asymmetry between the stellar magnetic poles and equator. The equations of radiative transfer for the Stokes' parameters are written in four variables, in spherical coordinates and are solved by the Monte Carlo method. The scattered Stokes' intensities (I, Q, U, and V) from a volume source located within the atmosphere are calculated as functions of the radial distance from the coordinate center, the polar angle, the cosine of the angle between the intensity and radial directions, and the time. The problem is assumed symmetric. The computer codes written are found to have application in the analytic study of the effects of terrestrial aerosol air pollutants. The polarization and transparency of the sky can be studied as functions of aerosol particle and molecular contents. Numerous applications to radiative transfer in planetary atmospheres are also evident. (Diss. Abstr. Int., B)

23473 STRUCTURE AND EVOLUTION OF HELIUM STARS. Dinger, Ann St. Clair. Evanston, Ill.; Northwestern Univ. (1971). 132p. University Microfilms Order No. 71-30,785.

Thesis.

Numerical models of helium stars were constructed in an effort to fit the models to the observed extreme-helium stars, i.e., those which have equivalent spectral types of O7–B5, absolute magnitudes brighter than –1.6, and weak or missing hydrogen lines. Main-sequence models of 1, 2, 4, and 8 $M_\odot$ were computed for Y = .98, Z = .02. The effect of the inclusion of the $^{14}N(\alpha,\gamma)^{18}F \rightarrow (e^+\nu)^{18}O$ reaction was investigated. It is shown that the addition of 10^{-3} of hydrogen by mass had a negligible effect on these models. One-solar-mass models with 2, 6, 14, 30, and 58% additional carbon were also computed. Carbon enrichment increased the luminosity, effective temperature, and central temperature of the model and decreased the central density. A four-solar-mass model with Z = .60 (0.02 solar metals and 0.58 additional carbon) was also computed. The four-solar-mass Z = .02 and Z = .60 models were evolved until carbon ignited in their cores under nondegenerate conditions. The evolution of the one-solar-mass, Z = .60 model was followed to the white dwarf state. Computations of the evolution of the one-solar-mass, Z = .02 model were stopped when the mass of the helium-exhausted core was 0.767 $M_\odot$. This model had crossed the main-sequence for hydrogen-burning and was evolving toward the red-giant region of the H–R diagram. (Diss. Abstr. Int., B)

23474 WHITE DWARFS. Shipman, Henry Longfellow. Pasadena, California Inst. of Tech. (1971). 162p. University Microfilms Order No. 72-487.

Thesis.

An attempt was made to use model-atmosphere techniques and intermediate-band photoelectric scans to determine the properties of white dwarfs. Model atmospheres were calculated with $6{,}000° \leq T_{eff} \leq 50{,}000°$ for solar composition, and $6{,}000° \leq T_{eff} \leq 22{,}000°$ for helium-rich (Y = 1) models. Photoelectric scans of some 37 white dwarfs were the observational basis of the thesis. (TSS) (Diss. Abstr. Int., B)

23475 HIGH-TEMPERATURE HEATING BY STELLAR WINDS. Wdowiak, Thomas John. Cleveland; Case Western Reserve Univ. (1971). 79p. University Microfilms Order No. 72-122.

Thesis.

The dissipation by a shock of the kinetic energy in a high-velocity stellar wind was investigated as a mechanism for producing x rays. The equations of mass, momentum, and energy were used to calculate the post-shock structure of an optically thin plasma cooled by thermal bremsstrahlung. Stellar wind velocity, mass motion rates, and electron densities derived from visible and rocket ultraviolet sepctroscopic observations and from observations of celestial x-ray sources were used to establish initial parameters in the post-shock flow problem. The temperature and density structure of the post-shock nonadiabatic flow establishes the x-ray spectrum in the 1- to 100-keV energy range. It is shown that this spectrum closely mimics the thermal bremsstrahlung spectrum of an isothermal plasma having an electron temperature of approximately ⅔ that of the relaxed plasma immediately after the shock in the quasi-adiabatic post-shock region. This result implies that the interpretation of x-ray spectra of such objects as Sco XR-1 as being due to an isothermal plasma may not be correct and could be interpreted as due to shock phenomena. Also, it is shown that the apparent absorption observed for sources in the 1-keV range may be due to the cooled post-shock matter rather than intervening interstellar matter. This has implications in density estimates of the interstellar medium. It is suggested that a more or less continuous flare phenomenon is occurring in x-ray sources of the spectral nature of Sco XR-1. It is further suggested that Wolf–

Rayet stars are not losing the high masses indicated by several authors and indeed high-velocity mass motion may not be involved in certain stars classed in the category of Wolf–Rayet stars. (Diss. Abstr. Int., B)

23476 MAGNETIC Ap STARS. Pikel'ner, S. B.; Khokhlova, V. L. (Sternberg Astronomical Inst., Moscow). Comments Astrophys. Space Phys.; 3: No. 6, 190-5(Nov-Dec 1971).

Ap stars include stars from FO to B4 with abnormally enhanced lines of particular elements changing periodically. From previous analyses of Ap stars a list of abundance anomalies was compiled. The anomalies are discussed and some difficulties are pointed out. (W.D.M.)

23477 HAIR TONIC FOR BLACK HOLES. Michel, F. Curtis (Rice Univ., Houston, Tex.). Comments Astrophys. Space Phys.; 3: No. 6, 163-7(Nov-Dec 1971).

All black holes are supposedly the same except for the mass, angular momentum, and electrostatic charge. "A black hole has no hair" is the description given by Wheeler to such an eventuality. Some excuses which are sure to be offered when it is discovered that black holes have richer astrophysical properties than expected are discussed. (W.D.M.)

23478 POSSIBLE EXPLANATION OF THE GAPS ON THE GIANT BRANCH OF M15. Demarque, Pierre; Mengel, John G.; Sweigart, Allen V. (Yale Univ. Observatory, New Haven). Astrophys. J.; 173: No. 1, L27-32(1 Apr 1972).

It is conjectured that fast rotating cores in the red giants of M15 might explain the possible existence of gaps on the giant branch of the cluster. In going outward through the transition layer between the rotating core and the nonrotating envelope the temperature gradient $|dT/dr|$ will increase abruptly. As the hydrogen-burning shell traverses this transition layer, a sudden increase in the luminosity might therefore be expected. A numerical simulation of this phenomenon has confirmed this prediction. Some implications of this hypothesis on the evolution of Population II stars are briefly discussed. (auth)

23479 SPECKLE INTERFEROMETRY: DIFFRACTION-LIMITED MEASUREMENTS OF NINE STARS WITH THE 200-INCH TELESCOPE. Gezari, D. Y.; Labeyrie, A.; Stachnik, R. V. (State Univ. of New York, Stony Brook). Astrophys. J.; 173: No. 1, L1-5(1 Apr 1972).

A new method is presented for repeating most of the classical Michelson–Pease measurements of stellar diameters. Stellar images are photographed "coherently" with a special camera. They contain a fine structure from which diffraction-limited information is extracted by optical processing. Nine of the stars observed were resolved, showing angular dimensions as small as 0.016". Limb darkening is evidenced in α Ori, and a faint companion is found for β Cep. (auth)

23480 RADIO RECOMBINATION LINES FROM PLANETARY NEBULAE. Terzian, Yervant; Balick, Bruce (Cornell Univ., Ithaca, N. Y.). Astrophys. Lett.; 10: No. 2, 41-7(Feb 1972).

Radio recombination line observations of the H85α line at ν = 10522.04 MHz ($\lambda \sim 3$ cm) of the planetary nebulae NGC 7027, IC 418, and NGC 6210 are presented, together with observations of the Orion Nebula, the Rosette Nebula, DR 21, and NGC 6888. The H85α line was unambiguously detected from all the above objects except NGC 6210 and NGC 6888, and the observed parameters are presented. LTE electron temperatures are computed, and the line widths are discussed. It is shown that, for NGC 7027 and IC 418, the linewidths can be explained satisfactorily by thermal broadening and nebular expansion. Stark broadening and turbulence seem to be negligible in NGC 7027 and IC 418. (auth)

23481 OBSERVATIONS OF ZETA PUPPIS. Heap, Sara R. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Lett.; 10: No. 2, 49-53(Feb 1972).

The visual line spectrum of ζ Puppis (O4f) cannot be matched by theoretical line profiles computed by Auer and Mihalas (1971) from their non-LTE models. The discrepancy between observation and prediction suggests that deviations from plane-parallel geometry and hydrostatic equilibrium must be accounted for in order for models to represent the atmospheric regions forming the observed lines. Relaxation of these classical assumptions may affect the value of effective temperature for this star derived from observations of its continuous spectrum. (auth)

23482 NEAR INFRARED PHOTOMETRY OF THE θ CORONAE BOREALIS SYSTEM. Roark, T. P. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Columbus); Baumert, J. H.; White, N. M. Astrophys. Lett.; 10: No. 2, 55-7(Feb 1972).

The integrated light output from the newly discovered binary system θ CrB was observed in the near infrared on June 25, 1970, August 10, and August 17, 1971. The observations indicate that the spectral type of the companion was between O5 and A5 at these times. (auth)

23483 Ap STARS WITH VARIABLE PERIOD? Renson, P. (Univ., Liege). Astron. Astrophys.; 18: No. 1, 159-62(Apr 1972). (In French).

The analysis of the data, especially for HD 32633 (new value of P: 6,4300 ± 0.0005 d), contradicts Rakos' suggestion of slow changes in P for periodic Ap stars. Thus HR 5597 is actually the only known Ap star with a variable period (slow periodic variation of P). (auth)

23484 o VELORUM, A NEW BETA CANIS MAJORIS STAR. Van Hoof, A. (Univ., Louvain, Belg.). Astron. Astrophys.; 18: No. 1, 51-4(Apr 1972).

Photoelectric and spectrographic observations reveal that o Vel is a variable star of the βCMa type with its brightness changing by 0.03m and its RV by 9 km/s in a period of 3h10m. There is an "outflow" of H of 3 km/s with respect to Si II and Mg II and of 5 km/s with respect to He I. The large scatter around the mean RV curve leaves a suspicion that either the RV curve is unstable, or that there are beats in the pulsation or that orbital motion is involved. The projected rotational velocity is 25 to 30 km/s. A Van Hoof effect cannot be discerned from the material. (auth)

23485 SPATIAL AND KINEMATIC PARAMETERS OF BINEBULOUS, CENTRIC, AND ANNULAR NEBULAE. Greig, W. E. (Univ. of Illinois, Urbana. Bradley Univ., Peoria, Ill.). Astron. Astrophys.; 18: No. 1, 70-8(Apr 1972).

Paper I (Greig, 1971a) showed that the agreement between the morphology and certain line ratios was 95%. Herein new and unpublished data are shown to agree with the predictions of Paper I. The important point is that class B nebulae are shown to follow the double sine curve of radial velocity versus galactic longitude which therefore shows that they have circular orbits and are likely Population I^+. The non-B's by contrast tend even to avoid the areas under the double sine curve, cannot have circular orbits and have a large velocity lag behind the circular velocity. The spread of B nebulae in the angular velocity versus galactocentric distance diagram is similar to that for Cepheids and supergiants. Oort's A = 14.0 km/s per kpc for a sample of 45. The second derivative, ω'', is definitely positive but depends somewhat on the sample chosen. For N = 45, ω'' = +0.14 km/s per kpc cubed for R_0 = 10.0 kpc. For the non-B's the ($\Delta\omega$, ΔR) diagram is a scatter diagram. The mean z, Z, and σ (V_r) of B nebulae are half the values of the C nebulae. These data all indicate that B nebulae are younger in Population than C nebulae. In the galactic plane B nebulae lie mostly (78%) in Isserstedt's spiral arms. The progenitors of C nebulae are LPV stars and the progenitors of B nebulae are giant GKM stars or some subset of them, particularly the symbiotic stars. It is thus shown for la première fois that nearly half of the local planetary nebulae have circular orbits and are likely intermediate Population I. (auth)

23486 STUDY OF HD 4180 AS COMPARED TO Be STARS WITH SMALL EXTENT ENVELOPES. Peton, A. (Observatoire, Meudon, France). Astron. Astrophys.; 18: No. 1, 106-10(Apr 1972). (In French).

The Hγ, Hδ, Hϵ equivalent widths variations of the HD 4180 star are characteristic of the shell. The emission decreases over a period of thirty years, until it disappears absolutely. Before it increases again, a very strong absorption by the external shell is observed, which affects the wings of the lines profiles. The equivalent width minimum of these three lines corresponds with the minimum of darkness of the shell; and the relevant profile is a characteristic of the star photosphere. (auth)

23487 OBSERVATIONAL PROPERTIES OF MODELS OF DETACHED CLOSE BINARIES. I. Giannone, P.; Giannuzzi, M. A. (Osservatorio Astronomico, Rome). Astron. Astrophys.; 18: No. 1, 111-20(Apr 1972).

Observational properties and the probability of discovery as eclipsing binaries were studied for models of detached systems. Masses of the primaries were varied from 0.8 to 10 $M_\odot$ and mass ratios in the range 0.1 to 1. Evolutionary stages of the component stars from the zero-age main sequence up to the red-giant phase were considered. (auth)

23488 STUDIES IN STELLAR EVOLUTION. X. HYDROSTATIC ADJUSTMENT. Henyey, L. G. (Univ. of California, Berkeley); Ulrich, Roger K. Astrophys. J.; 173: No. 1, 109-20 (1 Apr 1972).

The process of hydrostatic adjustment first discussed by Schwarzschild and Härm is analyzed in detail. This detailed

analysis leads to a better understanding of the mechanism by which a star becomes a red giant. It is felt that this type of analysis may be a substitute for the eigenvalue analysis now in use (Dennis; Sweigart) to test for the presence of a thermal instability. As numerical examples a perfect-gas polytrope of index 3 and a red giant of mass 2 $M_\odot$ just prior to helium-core ignition are treated. (auth)

23489 INFRARED EXCESSES AND FORBIDDEN EMISSION LINES IN EARLY-TYPE STARS. Allen, David A.; Swings, Jean Pierre (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett.; 10: No. 3, 83-7 (Mar 1972).

Low-excitation forbidden emission lines were detected in the spectra of early-type stars found to have prominent infrared excesses. The relationship of these objects to Be stars and planetary nebulae is briefly discussed. (auth)

23490 METAL ABUNDANCES AND INTERNAL TEMPERATURES OF DG WHITE DWARFS. Boehm, K. H.; Grenfell, T. C. (Univ. of Washington, Seattle). Astrophys. Lett.; 10: No. 3, 141-3(Mar 1972).

The extremely low metal abundances recently determined by Wegner (1971) for DF and DG white dwarfs were used in calculating new convective envelopes for DG stars. A rather high degeneracy and temperatures of only 2.15×10^5 to 2.73×10^5 K at the bottom of the convection zone were found. It is argued that, if Wegner's abundances are correct, the central temperature cannot be much higher than 4×10^5 K, a value which is about a factor of 10 lower than the Debye temperature. (auth)

23491 MACROTURBULENCE IN O STAR ATMOSPHERES? Scholz, M. (Univ., Heidelberg). Astrophys. Lett.; 10: No. 3, 137-9(Mar 1972).

Observations of lines in O-type spectra suggest that macroturbulence rather than rotation is the major line broadening agent in many O-star atmospheres. (auth)

23492 STUDIES CONCERNING THE EXISTENCE OF RUNAWAY STARS WITH COLLAPSED COMPANIONS. Gott III, J. Richard. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 173: No. 1, 227-34(1 Apr 1972).

Consider a close binary system with two stars of nearly equal mass. Let the first star explode, ejecting a significant fraction of its mass and leaving behind a collapsed remnant (neutron star or black hole). The remnant can then be trapped in an eccentric orbit about the second star. The resultant binary system is endowed with a large translational velocity since its momentum must balance the net momentum of the ejected matter of the explosion. The evidence is certainly not conclusive, but there are some indications that HD 59543 may be just such a runaway binary system. It consists of a B5 star with an unseen companion. The unseen companion has a mass in excess of $1.6M_\odot$ and might be a neutron star or a black hole. The fact that no more than one promising candidate was found suggests that such runaway binaries are infrequent compared with runaway single stars. (auth)

23493 UPPER LIMITS TO THE X-RAY LUMINOSITIES OF FIVE SUPERNOVAE. Ulmer, M.; Grace, V.; Hudson, H. S.; Schwartz, D. A. (Univ. of California, San Diego). Astrophys. J.; 173: No. 1, 205-11(1 Apr 1972).

Data from the OSO-III x-ray telescope were examined for evidence of x-ray emission from five optically detected extragalactic supernovae during the period March 1967–June 1968. Upper limits to the x-ray emission in the range 7.7 to 113 keV near optical maximum (within 30 days) fall in the range 10^{-8} to 10^{-10} ergs $(cm^2 s)^{-1}$. Reasonable estimates of the distances to these supernovae lead to upper limits on the total energies of from 10^{50} to 10^{51} ergs. (auth)

23494 NEUTRON–PROTON RATIO IN STARS EXPLODING FROM DENSE, HIGH-TEMPERATURE STATES. Schramm, David N.; Barkat, Zalman (California Inst. of Tech., Pasadena). Astrophys. J.; 173: No. 1, 195-204(1 Apr 1972).

Detailed calculations are presented showing the dependence of the freeze-out neutron–proton ratio (NPR) on relevant parameters for matter exploding from a hot ($T \gtrsim 10^{10}$ °K), dense ($\rho \gtrsim 5 \times 10^8$ g cm^{-3}) configuration. It is found that the freeze-out NPR value is extremely sensitive to the expansion rate as well as to the maximum temperature and density attained by the ejected matter. Application of these results to the study of nucleosynthesis in supernova models is discussed. (auth)

23495 SELECTED PROPERTIES OF MATTER AT HIGH DENSITY AND TEMPERATURE. EQUATION OF STATE AND RATES OF BETA PROCESSES AND ASSOCIATED NEUTRINO LOSSES. Barkat, Z.; Buchler, J.-R.; Wheeler, J. C. (California Inst. of Tech., Pasadena). Astrophys. J.; 173: No. 1, 183-94(1 Apr 1972).

Current data on relevant nuclear parameters and rates of β processes for a large number of nuclei are used to compute the key properties of matter which is assumed to be in nuclear statistical equilibrium at high density and temperature. For a range of density ($2 \leq \rho_9 \leq 15$), temperature ($3 \leq T_9 \leq 15$), and mean molecular weight per electron ($2.0 \leq \mu_e \leq 2.2$), the following parameters are given which are needed to compute the post-detonation behavior of highly evolved exploding stars: molecular weight μ, net binding energy B, $\zeta = -d \ln \mu_e/dt$, and the rate of the neutrino losses ϵ_ν. The qualitative behavior of the results and the possible errors associated with them are discussed. (auth)

23496 NUCLEOSYNTHESIS IN SILICON BURNING. Michaud, Georges; Fowler, William A. (California Inst. of Tech., Pasadena). Astrophys. J.; 173: No. 1, 157-81(1 Apr 1972).

A study was made of silicon burning in stellar explosions. A variety of initial compositions was considered, and an approximate method for summing the contribution of different zones in the star was developed. It is emphasized that summing over zones in which the the initial conditions vary resulted in realistic agreement with natural abundances for nuclei with $28 \leq A \leq 59$. The effects of some neglected aspects of the freezing of the participating nuclear reactions are discussed. Most nuclear species between ^{28}Si and ^{59}Co (except the very neutron-rich species ^{36}S, ^{46}Ca, ^{48}Ca, ...) may be generated in silicon burning. It is required that the initial material have a neutron enrichment $(\bar{N} - \bar{Z})/(\bar{N} + \bar{Z}) \approx 4 \times 10^{-3}$, which is consistent with the neutron enrichment to be expected from carbon or oxygen burning. The process must have occurred on a fast timescale ($t \lesssim 1$ s) at high temperature ($T \gtrsim 4.5 \times 10^9$ °K). (auth)

23497 TIME-DEPENDENT STUDIES OF DYNAMICAL INSTABILITIES IN SEMIDETACHED BINARY SYSTEMS. Bath, G. T. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 173: No. 1, 121-34(1 Apr 1972).

Both linear and nonlinear time-dependent methods were used to investigate the stability of contact members of semidetached binary stars to dynamical perturbations. Assuming a heuristic surface boundary condition of constant pressure at a fixed radius and adiabatic spherically symmetric motion, the linear analysis showed stellar envelopes in such systems to be unstable in a significant region of the Hertzsprung–Russell diagram. With the assumption of ionization equilibrium during the outburst, a nonlinear hydrodynamic, but adiabatic, analysis showed that the instability results in the rapid shedding of material from the surface and the setting up of adiabatic gradients within the star. Estimated variations in surface luminosity were similar to the changes observed in U Geminorum stars, but not novae, and the reasons for this are discussed. (auth)

23498 EFFECT OF COMPOSITION GRADIENTS ON A CONVECTIVE CORE. Boyle, Robert J. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 173: No. 1, 103-8(1 Apr 1972).

The effects of composition gradients due to helium burning during the core flash in a low-mass Population II star on the fundamental laminar mode of convection were investigated. The results imply that the expected composition gradients are insufficient to inhibit convection even in the center of the core. (auth)

23499 DECOUPLING OF MAGNETIC FIELDS IN DENSE CLOUDS WITH ANGULAR MOMENTUM. Nakano, Takenori; Tademaru, E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 173: No. 1, 87-101(1 Apr 1972).

Magnetic fields and angular momentum are problems in the formation of stars in a contracted interstellar cloud. The ionization rate of hydrogen by cosmic rays within dense clouds is calculated in order to investigate the efficiency of ambipolar diffusion in decoupling the magnetic flux from the gas during the collapse of the clouds. The loss of angular momentum via magnetic-dipole radiation of hydromagnetic waves is investigated to estimate the lifetime of clouds whose gravitational, kinetic, and centrifugal forces are in balance. During these "equilibrium" states the cloud may be able to lose sufficient magnetic flux to allow the formation of 1 $M_\odot$ protostars. (auth)

23500 NGC 2516 AND THE PLEIADES GROUP. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J.; 173: No. 1, 63-86(1 Apr 1972).

UBV observations to visual magnitude 16 are given for stars in NGC 2516 together with new UBV observations of members of IC 2602 and 2391 and intermediate-band results for the members of the ζ Sculptoris cluster. (W.D.M.)

23501 APPARENT DISCREPANCY BETWEEN PULSATION AND EVOLUTION MASSES FOR CEPHEIDS. Iben, Icko Jr.;

Tuggle, Roy Slaton (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 173: No. 1, 135-55(1 Apr 1972).

Results of new theoretical pulsation calculations in the linear nonadiabatic approximation are reported. Both Q values and the location of blue edges in the H–R diagram are presented for masses and compositions that are of interest in connection with classical Cepheids. It is shown that estimates of Cepheid masses obtained by comparing observational data with theoretical Q values can be made to agree with mass estimates obtained by comparing with results of theoretical evolution calculations if any one of the following is true: (a) absolute magnitudes assigned to Cepheids in open clusters and associations are systematically too dim by ~0.3 mag, (b) the conversion from a raw mean color to surface temperature T_e overestimates log T_e by $\Delta \log T_e \sim 0.025$, (c) the helium abundance assigned to evolutionary models is too low by $\Delta Y \sim 0.14$. Comparison with theoretical "blue edges" in both the H–R diagram and the period–magnitude diagram suggests that a combination of solutions (a) and (b) with emphasis on (a) provides the most likely resolution of the apparent discrepancy. One consequence of this resolution is a possible increase by ~0.2 to 0.3 mag in distance moduli for external galaxies and therefore possibly an increase of perhaps 10 to 15% in estimates of the Hubble time. (auth)

23502 STELLAR EVOLUTION TOWARD PRE-SUPERNOVA STAGE. I. CARBON AND OXYGEN STARS OF 5, 10, AND 30 SOLAR MASSES. Ikeuchi, Satoru (Kyoto Univ.); Nakazawa, Kiyoshi; Murai, Tadayuki; Hoshi, Reiun; Hayashi, Chushiro. Progr. Theor. Phys. (Kyoto); 46: No. 6, 1713-37(Dec 1971).

The evolution of carbon–oxygen stars of 5M, 10M, and $30M_\odot$ is computed from a pre-carbon-burning contraction stage to a pre-supernova stage through the phases of central burning of C, Ne, O, Mg, Si, and Ni. These stars are regarded as representing the cores inside the helium shell-source of ordinary evolved stars. The computation is made for the two alternative cases, with and without neutrino production by electron–neutrino interaction. It is found that in the case without neutrinos the stars contract nearly homologously with structure almost similar to the polytrope of index 3 and each central burning begins gently. Finally, the stars of 5M and $10M_\odot$ become unstable on account of the photodisintegration of iron, while the star of $30M_\odot$ becomes unstable in a central neon-burning phase by electron pair production. In the case with neutrinos, energy loss through neutrinos accelerates the evolution and, at the same time, gives rise to a deviation from the homologous contraction. The stars tend to be centrally condensed with evolution, and both O and Si begin to burn at the center as strong flashes. Finally, all of the stars become unstable after the formation of an iron core. (11 figs., 9 tables, 21 references) (auth)

23503 INVESTIGATIONS IN GRAVITATIONAL COLLAPSE AND THE PHYSICS OF BLACK HOLES. Christodoulou, Demetrios L. Princeton, N. J.; Princeton Univ. (1971). 139p. University Microfilms Order No. 72-2696.

Thesis.

The physics of gravitational collapse and its final states, the collapsed objects called black holes, is considered. It is known that a star at the end point of thermonuclear evolution will be unstable against gravitational collapse if its mass is larger than a certain critical mass. Will radiation be similarly unstable above a certain critical mass–energy and undergo gravitational collapse? This question is treated in considering an imploding and reexploding scalar pulse of radiation and is answered in the affirmative. Will a black hole always be stationary? Will the physics of the dynamical region inside the event horizon never come into play? It is shown that the dynamics of the interior geometry comes into play in the final stages of collapse of the Universe itself, and the Schwarzschild singularity is amalgamated into the Friedman singularity. Various processes are shown that extract energy from a rotating black hole. The first such method was investigated by Penrose. Here, the concepts of irreducible mass and of reversible and irreversible transformations in black holes are introduced. The total mass–energy of a rotating black hole is split into the irreducible mass and the rotational energy. The consequences of this are investigated. Thus, it is shown that one can extract 29% of the total mass energy of an extreme black hole. The results are generalized to a black hole with angular momentum and charge. This is the most general black hole, endowed with a magnetic field. The concept of irreducible mass is given geometrical meaning in the equation $S = 16\pi m_{ir}^2$, relating the irreducible mass to the surface area of the Killing horizon. The necessary conditions for splitting of a black hole are given, together with a conjecture about reversibility of the process of coalescense of two black holes. The tightest bound orbits of test particles in the field of a black hole are considered. A classical analog of annihilation is thus found, in which a particle radiates 100% of its rest mass in electromagnetic waves in spiralling into a black hole, for a special choice of the charges and angular momentum of the test particle and the black hole. (Diss. Abstr. Int., B)

23504 POSITIONS AND PROPER MOTIONS OF 127 STARS IN THE REGION OF WX CENTAURI. Gatewood, George; Eichhorn, Heinrich (Univ. of South Florida, Tampa). Mon. Notic. Roy. Astron. Soc.; 155: No. 4, 415-24(1972).

The positions and proper motions in the system of the FK4 of the star suggested by Eggen as the optical component of the x-ray source Cen X-2 and 126 other stars are given. WX Centauri does not seem to be an obvious member of a comoving group of stars; its position in the proper motion plot does, however, suggest that it is a Population I object. Two relatively faint red stars are identified as possible members of the Scorpio–Centaurus Association. (auth)

23505 SOME ELEMENTARY APPLICATIONS OF THE VIRIAL THEOREM TO STELLAR DYNAMICS. Chandrasekhar, S.; Elbert, Donna D. (Univ. of Chicago). Mon. Notic. Roy. Astron. Soc.; 155: No. 4. 435-47(1972).

The dynamical evolution of spherical and spheroidal systems of mass points is examined with the aid of the scalar and the tensor forms of the virial theorem. Spherical systems with positive total energy tend to disperse to infinity while those with negative total energy execute periodic oscillations of finite amplitude. Spheroidal systems with positive total energy exhibit expansion like the spherical systems; but they also become less oblate (and sometimes actually become prolate) if they are initially oblate, and less prolate if they are initially prolate. Spheroidal systems with negative total energy collapse to smaller volumes while enhancing their initial oblateness or prolateness. (auth)

23506 STELLAR LUMINOSITY FUNCTION FROM THE METHOD OF MEAN ABSOLUTE MAGNITUDES. Wanner, James F. (Naval Observatory, Washington, D. C.). Mon. Notic. Roy. Astron. Soc.; 155: No. 4, 463-81(1972).

The method of mean absolute magnitudes for the determination of the luminosity function is examined in detail and its reliability tested. The method itself is found to contain inherent uncertainties which can produce variations of ±30% in the luminosity function, quite apart from errors in the observational data. The absolute magnitude of the peak in the luminosity function also varies according to the computational tactics adopted; Luyten's approach leads to a peak at $M_B = +15.7$ while the present study indicates a peak near $M_B = +12$. (auth)

23507 INVESTIGATIONS IN THE PHYSICS OF NEUTRON STARS. Rhoades, Clifford Edward Jr. Princeton, N. J.; Princeton Univ. (1971). 196p. University Microfilms Order No. 72-2741.

Thesis.

The following aspects of the problem of neutron stars are considered: effect of a new equation of state valid at densities above 10 times nuclear densities on equilibrium configurations of neutron stars and their stability; effects of the periodic crystal potential in neutron star crusts upon both electron and neutron transport properties; and use of a variational principle to obtain an equation of state for intermediate (that is near nuclear) densities which maximizes the critical mass of a neutron star. (TSS) (Diss. Abstr. Int., B)

23508 STUDY OF SC STARS. Greene, Arthur Edward. Columbus, Ohio; Ohio State Univ. (1971). 278p. University Microfilms Order No. 72-4505.

Thesis.

This study examines several aspects of the atomic and molecular spectra of stars that appear to be intermediate between the spectral classes S and C. Image-tube spectrograms covering the region from 3840 Å to 7200 Å at a dispersion of 66 Å/mm were obtained for 51 stars including S, SC, and carbon stars. These spectrograms were reduced by means of direct intensity traces and residual-intensity measurements were made of several atomic features due to Ba, Zr, Sc, La, and Li. In the red spectral regions corrections were made for the blending of CN by comparing with synthetic CN spectra. Visual estimates were made of the strengths of the C_2 Swan bands. To provide color temperatures and direct measurements of CN absorption, photometric data were obtained for 21 stars using an 8-color system that covers the region from 7100 to 11,000 Å. Temperature estimates of the remaining stars were made by comparing the energy distribution from their spectrograms with the spectrograms of these 21. (TSS) (Diss. Abstr. Int., B)

23509 PHOTOELECTRIC INVESTIGATIONS OF THE FAINT ECLIPSING VARIABLE STARS TY URSAE MAJORIS AND AZ VIRGINIS AND THE DETERMINATION OF THE SPECTRAL CLASSIFICATION FOR THE ECLIPSING VARIABLE STARS WY CANCRI, AZ VIRGINIS, AND TZ BOOTIS. Durgin, Harold Everett. Washington, D. C.; Georgetown Univ. (1971). 206p. University Microfilms Order No. 72-4218.

Thesis.

The eclipsing binary stars TY Ursae Majoris and AZ Virginis were observed photoelectrically at the U. S. Naval Observatory Flagstaff Station. Blue and yellow light curves were obtained for TY Ursae Majoris. The observed times of minima indicated a period of 0.35461426 days. This is considerably longer than periods derived by other investigators. Solutions for the orbital and eclipse elements were completed for both colors. The Fourier coefficients obtained from an analysis of the light outside eclipse are compared with theoretical Fourier coefficients calculated using the adopted orbital elements. The photoelectric observations of AZ Virginis were made in order to better determine the period. Previous visual and photographic investigations indicated periods of 0.297 and 0.349 days. The findings in this study confirm the longer period. The spectra for the three eclipsing binaries, AZ Virginis, TZ Bootis, and WY Cancri were obtained. The MKK classification was utilized to determine the combined spectrum of each system as well as its luminosity class. (Diss. Abstr. Int., B)

23510 ANALYSIS OF THE SPECTRUM OF THE IRREGULAR VARIABLE CY CYGNI IN THE WAVELENGTH REGION 5000 TO 6700 A. Culver, Roger Bruce. Columbus, Ohio; Ohio State Univ. (1971). 103p. University Microfilms Order No. 72-4460.

Thesis.

The spectrum of the irregular variable CY Cygni was analyzed in detail over the wavelength range 5000 to 6700 Å and element abundances relative to the solar-composition star 63 Cygni were calculated. Only sodium and the s-process heavy metals were found to be overabundant relative to be solar composition. The space motion, temperature, and luminosity of the star were determined as well, and it is suggested that CY Cygni represents a normal stage of evolution of a 3- to 4-$M_{\odot}$ star, which is intermediate between the barium stars and the S stars. (Diss. Abstr. Int., B)

23511 BROAD-BAND INDEX FOR THE EFFECTIVE TEMPERATURES OF NORMAL LATE TYPE STARS. Chaturvedi, J. P. (Uttar Pradesh State Observatory, Naini Tal, India). Bull. Astron. Inst. Czech.; 23: No. 1, 48-50(1972).

An index for temperatures of stars, based on B, V, and R magnitudes, was obtained. It was found that $\{\Theta_e, [(B-V)^2 + (V+R)^2]^{1/2}\}$ relations are well-defined linear equations for stars of spectral type later than G0 and belonging to different luminosity classes. (auth)

23512 FREQUENCY DISTRIBUTION OF ASTRONOMICAL OBJECTS AND PHENOMENA ACCORDING TO THEIR AGE AND LIFETIME. Kopecky, M. (Astromomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 1, 51-5(1972).

Relations between the frequency distribution functions of phenomena and objects are derived according to their lifetime, age, and certain other factors, and certain possibilities of applying these relations to astronomical and astrophysical research are discussed. (auth)

23513 EQUIVALENT WIDTH DATA FOR SEVERAL AM STARS IN CLUSTERS AND COMPARISON STANDARDS. Smith, Myron A. (Steward Observatory, Tucson, Ariz. Kitt Peak National Observatory, Tucson, Ariz.). Astron. Astrophys., Suppl. Ser.; 5: No. 2, 81-108(Feb 1972).

The equivalent width data used in curve of growth analyses in another study (Smith 1971) are presented for sixteen Am stars and four standards. These data are compared with available equivalent width material from four other observatories. (auth)

23514 FOUR-COLOR AND Hβ PHOTOMETRY FOR THE BRIGHTER A0 TYPE STARS. Crawford, D. L.; Barnes, J. V.; Gibson, J.; (and others) (Kitt Peak National Observatory, Tucson, Ariz.). Astron. Astrophys., Suppl. Ser.; 5: No. 2, 109-28 (Feb 1972).

Intermediate and narrow-band photoelectric photometry is presented for 572 A0-type stars brighter than $m_v = 6.5$ m. (auth)

23515 NEW KINEMATICAL DATA FOR BRIGHT SOUTHERN OB STARS. Lesh, Janet Rountree (Leiden Observatory) Astron. Astrophys., Suppl. Ser.; 5: No. 2, 129-66(Feb 1972).

New distance moduli and distances (based on the MK spectral types of Hiltner et al., 1969, and UBV photometry from the Royal Observatory, Cape of Good Hope), new proper motions on the FK4 system, and newly evaluated and averaged radial velocities are presented for 440 bright O and early B stars south of declination −20°. These data were prepared for a study of the velocity field of the southern portion of the Gould Belt. (auth)

23516 NEW DOUBLE STARS (6th SERIES) DISCOVERED AT NICE WITH THE 50 CM REFRACTOR. Couteau, P. (Observatorie, Nice). Astron. Astrophys., Suppl. Ser.; 5: No. 2, 167-74(Feb 1972).

A list of 100 pairs discovered with the 50-cm refractor of the Nice Observatory is given. (auth)

23517 ORBIT OF THE VISUAL BINARY β 989 = ADS 15281. Couteau, P.; Morel, P. J. (Observatoire, Nice). Astron. Astrophys., Suppl. Ser.; 5: No. 2, 175-80(Feb 1972). (In French).

Improved orbital elements are given for the visual binary ADS 15281; 21h42m4 + 25°25′ (1950); 4.8 to 5.3 Sp F5. (auth)

23518 ORBITS OF TWO VISUAL BINARIES. Couteau, P. (Observatorie, Nice). Astron. Astrophys., Suppl. Ser.; 5: No. 2, 181-3(Feb 1972). (In French).

The orbital elements of two binaries ADS 16046 and ADS 16165 are given. (auth)

23519 VELOCITY EFFECTS IN TRIPLE STELLAR SYSTEMS. Szebehely, Victor (Univ. of Texas, Austin). Astron. J.; 77: No. 2, 169-77(Mar 1972).

Previous results concerning the evolution and eventual disintegration of triple stellar systems are extended to more general initial conditions. Specifically, the initial velocities are different from zero. The initial value of the virial coefficient is 1 for some of the numerical experiments and less for others. The total energy of the system is negative in all cases investigated since the process of disintegration is trivial and predictable for positive energy. The following results are obtained: (i) it is demonstrated that parameters frequently used to describe triple stellar systems, i.e., the total energy, virial coefficient, and angular momentum cannot predict—even qualitatively—the behavior of the system; (ii) a parametric study shows the continuous process from temporary elliptic ejection to permanent hyperbolic escape of one of the stars of the system and reveals the effect of the initial velocity on the stability of the triple system; (iii) the distintegration times established by high-precision numerical integrations are found to be between 10^7 and 10^9 y; (iv) systems with large angular momentum are more stable and are more successful in delaying disintegration than those with zero angular momentum. (auth)

23520 PARALLAX AND ORBITAL MOTION OF THE TWO NEARBY LONG-PERIOD VISUAL BINARIES GROOMBRIDGE 34 AND ADS 9090. Lippincott, Sarah Lee (Swarthmore Coll., Pa.). Astron. J.; 77: No. 2, 165-8(Mar 1972).

Measurements of photographs taken with the Sproul 24-inch refractor between 1937 and 1970 on Groombridge 34 A and B yield $\pi_{abs} = +0.283 \pm 0.005''$ (p.e.). A provisional orbit was computed, including the Sproul B − A positions and those measured on plates from the McCormick Observatory, in addition to all other available data. Measurements from plates taken with the Sproul refractor on ADS 9090 A and B over the interval 1938–1969 yield $\pi_{abs} = +0.092 \pm 0.005''$. Relative positions B − A are given. (auth)

23521 ASTROMETRIC STUDY OF FOUR BINARY STARS. Heintz, W. D. (Swarthmore Coll., Pa.). Astron. J.; 77: No. 2, 160-5(Mar 1972).

Orbits, parallaxes, and masses were derived for the visual binaries ADS 8197, Wold 424, 99 Her, and Kpr 112. The results are based on a total of more than 1000 Sproul astrometric plates. The components of Wolf 424 appear to be the least-massive visible stars currently known. (auth)

23522 PHOTOELECTRIC UBV PHOTOMETRY OF TY BOOTIS. Carr, Roger B. (Carleton Coll., Northfield, Minn.). Astron. J.; 77: No. 2, 155-9(Mar 1972).

An orbital solution for the short period W UMa-type eclipsing variable TY Boo was found from 391 photoelectric UBV observations. The solution parameters were consistent with the photometric results which indicated main-sequence G3 and G7 components. Nonrectifiable distortions in the light curves limited the accuracy of the analysis. (auth)

23523 RI PHOTOELECTRIC PHOTOMETRY OF EPSILON CORONAE AUSTRINAE. Hernandez, Carlos A. (Observatorio Astronomica, La Plata). Astron. J.; 77: No. 2, 152-4(Mar 1972).

Light and color curves of ϵ Cr A in RI are presented. These observations were simultaneously made with those by Tapia in UBV and whose results are already published. (auth)

23524 PHOTOMETRIC DATA FOR 139 SUPERGIANTS. Fernie, J. D. (Univ. of Toronto, Richmond Hill, Ont.). Astron. J.; 77: No. 2, 150-1(Mar 1972).

Photometric data for 139 supergiants, originally determined on

the Lick six-color system by Kron, are transformed to the Johnson UBVRI system. Approximate color excesses are given. (auth)

23525 uvby PHOTOMETRY OF WHITE-SDWARF STARS. Graham, J. A. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 77: No. 2, 144-50(Mar 1972).

New magnitudes and colors are presented for 36 white-dwarf stars from the Eggen–Greenstein lists. The photometry is on the intermediate-band uvby system devised by Strömgren. The new measurements are combined with the observations of 44 stars published previously to illustrate further some of the characteristics of the uvby system in this particular application. Attention is drawn to the $M_V-(b-y)$ diagram in which the white dwarfs appear to lie on a single sequence within the accuracy of the presently available absolute magnitudes. (auth)

23526 RADIAL VELOCITIES OF 65 EARLY-TYPE STARS. Abt, Helmut A.; Levy, Saul G.; Gandet, Thomas L. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 77: No. 2, 138-43(Mar 1972).

These stars are most of the 1061 OB stars and Cepheids being observed for proper motions at the U. S. Naval Observatory and that previously lacked radial velocities. Although their space motions are not discussed, these stars include three possible runaway stars and two newly discovered spectroscopic binaries with preliminary orbital elements. Half of the stars are variable in velocity, a fraction that is typical for OB stars. (auth)

23527 CAN ASTROPHYSICAL ABUNDANCES BE TAKEN SERIOUSLY. Worrall, G. (Univ. of Maryland, College Park); Wilson, A. M. Nature (London); 236: No. 5340, 15-18(3 Mar 1972).

It is argued that the determination of the astrophysical abundances of elements rests on several assumptions, particularly the existence of microturbulence, for which there is no experimental or theoretical justification. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 22893, 23475, 23622, 23879, and 23989.

23528 LUNAR OCCULTATIONS OF THE GALACTIC CENTER REGION IN HI, OH, AND CH_{2O} LINES. Sandquist, Aage. College Park, Md.; Univ. of Maryland (1971). 214p. University Microfilms Order No. 72-1647.

Thesis.

In the period from January, 1968 to March, 1970, ten lunar occultations of the galactic center region were observed with the 140-foot radio telescope at the National Radio Astronomy Observatory, using a 100-channel autocorrelator for the first two occultations, and a 413-channel autocorrelator for the remaining eight. Seven events were observed in the 1667-MHz OH line, five in the 1665-MHz OH line, one in the 1720-MHz OH line, six in the 1420-MHz HI line and, two in the 4830-MHz CH_2O line. During five occultations, the 1665- and 1667-MHz OH lines and the 1420-MHz HI line were observed simultaneously. Continuum occultation curves at the above frequencies were obtained. The continuum radio source, Sgr A, was occulted seven times, the weaker source, G359.4–0.1, once. Baseline-corrected antenna temperature contour maps on grid of velocity versus sidereal time were produced for all the observed lines. Opacity contour maps were also produced, as well as differentiated contour maps of selected parts of the occultations. (TSS) (Diss. Abstr. Int., B)

23529 PULSAR THEORY. I. DYNAMICS AND ELECTRODYNAMICS. Goldreich, P. (California Inst. of Tech., Pasadena); Pacini, F.; Rees, M. J. Comments Astrophys. Space Phys.; 3: No. 6, 185-9(Nov-Dec 1971).

An attempt is made to examine critically some currently popular theories of pulsar electrodynamics. The hypothesis that pulsars are spinning neutron stars deriving their power from rotational energy is adopted. (W.D.M.)

23530 OBSERVATION OF VARIABLE CIRCULAR POLARIZATION IN THE OPTICAL EMISSION OF THE X-RAY SOURCE Sco X-1. Gnedin, Yu. N.; Shulov, O. S. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 348-50(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 507-10(5 Nov 1971).

The circular polarization p_v, of Sco x-1 was observed in the short- and long-wave color bands for 14 nights in the period from June 23 to July 29, 1971, by using a single-channel photoelectric polarimeter placed at the Cassegrain focus of the Byurokan 48-cm reflector. The observations yielded $p_v = -3.12 \pm 0.44\%$ and $-3.00 \pm 0.41\%$ in the short- and long-wave regions, respectively. (W.D.M.)

23531 PLAUSIBLE ENERGY SOURCE AND STRUCTURE FOR QUASI-STELLAR OBJECTS. Daltabuit, E.; Cox, D. (Univ. of Wisconsin, Madison). Astrophys. J.; 173: No. 1, L13-17(1 Apr 1972).

If a collision of two large, massive, fast gas clouds occurs, their kinetic energy is converted to radiation in a pair of shock fronts at their interface. The resulting structure is described, and the relevance of this as a radiation source for QSOs is considered. (auth)

23532 REDSHIFTS OF SOUTHERN RADIO SOURCES. Peterson, Bruce A. (Australian National Univ., Canberra); Bolton, J. G. Astrophys. J.; 173: No. 1, L19-21(1 Apr 1972).

Spectroscopic observations are reported for 15 radio sources. Redshifts were measured for nine QSOs and one galaxy. (auth)

23533 CIRCULAR POLARIZATION OF HD 226868, NGC 1068, NGC 4151, 3C 273, AND VY CANIS MAJORIS. Gehrels, T. (Univ. of Arizona, Tucson). Astrophys. J.; 173: No. 1, L23-5 (1 Apr 1972).

No meaningful amounts of circular polarization were found on NGC 1068, NGC 4151, 3C 273, or on HD 226868 (the star sometimes identified with Cyg X-1). A small amount of circular polarization in the infrared appears to be present in VY CMa. (auth)

23534 STRUCTURE OF PULSAR MAGNETOSPHERES. Roberts, D. H.; Sturrock, P. A. (Stanford Univ., Calif.). Astrophys. J.; 173: No. 1, L33-7(1 Apr 1972).

Currents drawn from the neutron-star surface may lead to surface heating and hence to evaporation. Substantial accumulation of evaporated gas can occur only in the "force balance" regions where gravitational and centrifugal forces balance. It is argued that the Y-type neutral points, separating closed and open field lines, must be at the same location. For this model, the braking index $n = 1/3$ and the expected period–pulse-width distribution and period–age distribution agree well with observational data. A glitch is interpreted as an instability leading to the ejection and/or dumping of accumulated gas. (auth)

23535 INTERSTELLAR CN EXCITATION AT 2.64 mm. Penzias, A. A. (Bell Telephone Labs., Holmdel, N. J.); Jefferts, K. B.; Wilson, R. W. Phys. Rev. Lett.; 28: No. 12, 772-5(20 Mar 1972).

A sensitive search was made for 2.64-mm line emission from a cloud of CN, whose excitation is known from optical measurements, with essentially a null result. This provides strong support for the proposition that the excitation temperature deduced from the optical CN lines is equal to the temperature of the microwave background. (auth)

23536 ATOMIC HYDROGEN OBSERVATIONS TOWARD W3. Chaisson, Eric J. (Harvard Coll. Observatory, Cambridge, Mass.). Astron. Astrophys.; 18: No. 1, 149-53(Apr 1972).

Observations of interstellar hydrogen were made in the direction of the radio nebula W3. A 21-cm absorption profile was found to be coincident in radial velocity with a well-known Cnα recombination line. An unidentified recombination line, if assumed to be an additional Doppler-offset Cnα emission, is shown to have a radial velocity coincident with a second neutral-hydrogen absorption feature. Spin temperatures characteristic of three distinct gas condensations were calculated to have values between 35 and 130°K. (auth)

23537 SOFT X RAYS FROM SUPERNOVA REMNANTS. Ilovaisky, Sergio A.; Ryter, Charles (Observatoire de Paris, Meudon, France. CEN, Saclay, France). Astron. Astrophys.; 18: No. 1, 163-5(Apr 1972).

Some of the results concerning the observability of soft x-ray emission from supernova remnants presented in a previous paper (Ilovaisky and Ryter, 1971) are reviewed in the light of several new facts. The maximum linear diameter up to which a given remnant is likely to be a soft x-ray source is discussed quantitatively and depends on remnant distance from the galactic plane. An updated list of probable soft x-ray sources is proposed. (auth)

23538 HYDRODYNAMIC MODEL CALCULATIONS FOR SUPERMASSIVE STARS. I. THE COLLAPSE OF A NONROTATING 0.75×10^6 $M_\odot$ STAR. Appenzeller, I.; Fricke, K. (Univ., Goettingen, Ger.). Astron. Astrophys.; 18: No. 1, 10-15(Apr 1972).

In order to test Fowler's models for QSOs and exploding galaxies the pre-main-sequence contraction and the relativistic dynamical collapse of a nonrotating 0.75×10^6 $M_\odot$ supermassive star were calculated by solving numerically the (relativistic) hydrodynamic

equations. In contrast to earlier estimates it was found that in such a star the rapid burning of hydrogen cannot halt the collapse before the Schwarzschild radius is reached. Thus, a nonrotating 0.75×10^6 $M_\odot$ star will not undergo relaxation oscillations but will end up as a supermassive black hole after a rather short life time of some 10^3 years. (auth)

23539 PARAMETERS OF 61 PULSARS. Manchester, R. N.; Taylor, J. H. (Univ. of Massachusetts, Amherst). Astrophys. Lett.; 10: No. 2, 67-70(Feb 1972).

The principal parameters of 61 pulsars are listed in tabular form, together with references to the sources of information. (59 references) (auth)

23540 PULSARS, SUPERNOVA REMNANTS, AND THE PULSAR PERIOD–LUMINOSITY RELATION. Tsarevskii, G. S. (Special Astrophysical Observatory, Moscow). Astrophys. Lett.; 10: No. 2, 71-6(Feb 1972).

The relative space positions of pulsars and supernova remnants are compared on the basis of the "runaway" pulsar hypothesis. The value of the maximum observable separation, 130 pc, obtained from predictions for the upper limit of pulsar velocity and SNR age, is used as the criterion for selecting pulsar–SNR pairs. There is a good correlation between pulsar dispersion measure and supernova distance for the pairs thus selected (20 SNR's and 23 pulsars). An independent estimate of the average interstellar electron density gives $\langle n_e \rangle = 0.045 \pm 0.010$ cm^{-3}. The pulsar period–luminosity relation indicates an abrupt decrease of luminosity (by a factor of 100) at pulsar periods of 0.6 to 0.8 sec. The available data appear to support the "runaway" hypothesis. (auth)

23541 INTERPRETATION OF VARIABLE COMPONENTS IN EXTRAGALACTIC RADIO SOURCES BY SYNCHRO-COMPTON THEORY. Blandford, R. D.; Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 10: No. 2, 77-82(Feb 1972).

Stellar-mass objects, collapsing at a rate ~1 per yr, can provide enough energy to power active galactic nuclei and typical QSS's. Such objects may emit their rotational energy as electromagnetic waves at frequencies ≤1 kHz. If these waves impinge onto a surrounding plasma of suitable density they will accelerate relativistic electrons, which then radiate in the radio band. This process can be efficient enough to account for the intensity of the compact components associated with some extragalactic radio sources. The calculated spectrum, time dependence, and other properties seem compatible with the radio observations. (auth)

23542 BROADENING OF RADIO RECOMBINATION LINES BY ELECTRON COLLISIONS. Peach, G. (University Coll., London). Astrophys. Lett.; 10: No. 3, 129-30(Mar 1972).

The broadening by electron collisions, of radio recombination lines in hydrogen, was calculated using the impact theory of Baranger. The degeneracy of the energy levels nl, l = 0, 1, 2 ... with respect to l was explicitly taken into account and it was proved that the net effect of collisions which do not cause a change of principal quantum number n is negligible. This is in agreement with the assumptions of earlier workers. (auth)

23543 PRECISE OPTICAL POSITIONS OF NINE COMPACT RADIO SOURCES. Couper, Heather A. Cambridge Univ., Eng.). Astrophys. Lett.; 10: No. 3, 121-4(Mar 1972).

Positions relative to AGK 3 were measured for nine optical objects identified with radio sources of small angular diameter. Among the best radio determinations the rms difference between optical and radio position is of order 0.6 arc sec in either coordinate, which is equal to the standard error of the radio position, thus confirming the optical identification and indicating the coincidence of optical and radio objects. (auth)

23544 OBSERVATIONS OF RECOMBINATION LINES AT 16.5 GHz. Papadopoulos, G. D. (Massachusetts Inst. of Tech., Cambridge); Lo, K. Y.; Rosenkranz, P.; Chaisson, E. J. Astrophys. Lett.; 10: No. 3, 89-92(Mar 1972).

Measurements of recombination lines of excited hydrogen in Orion A, W3, W49, and W51 were made at 16.56 GHz. Assuming local thermodynamic equilibrium, mean electron temperatures were found to be 11,000 K for each nebula. (auth)

23545 WATER SOURCES ASSOCIATED WITH OH EMISSION IN THE SOUTHERN MILKY WAY. Johnston, K. J. (Naval Research Lab., Washington, D. C.); Robinson, B. J.; Caswell, J. L.; Batchelor, R. A. Astrophys. Lett.; 10: No. 3, 93-8(Mar 1972).

A search for H_2O emission at 22.23508 GHz among southern OH emission sources has located five new sources, four of which are associated with H II regions showing intense continuum radiation. Water vapor was detected near 20% of the OH emitters observed in this search. (auth)

23546 NATURE OF VARIABLE RADIO STRUCTURES. Kurilchik, V. N. (Sternberg Astronomical Inst., Moscow). Astrophys. Lett.; 10: No. 3, 115-19(Mar 1972).

A model of variable radio structures as outbursts of clouds of relativistic electrons into stationary magnetic field tubes that expand in a regular manner with distance from nuclei, is considered. Motion and expansion of compact radio sources with apparent super-light velocities and other phenomena, which take place in this model, are discussed. (auth)

23547 STRUCTURE AND SPECTRUM OF CYGNUS A. Mills, D. M. (Univ. of California, Santa Cruz). Astrophys. Lett.; 10: No. 3, 109-13(Mar 1972).

The observed structure and spectrum of the Cygnus A radio clouds can be explained by confinement of the clouds by the ram pressure of the external medium and depletion of high-energy electrons due to synchrotron losses during the early history of the source. Synchrotron self-absorption accounts for the low-frequency turnover in the spectrum for reasonable magnetic field strengths. (auth)

23548 IDENTIFICATION OF SOUTHERN QUASI-STELLAR OBJECTS. II. Peterson, B. A. (Australian National Univ., Canberra); Bolton, J. G. Astrophys. Lett.; 10: No. 3, 105-8 (Mar 1972).

Eighteen new quasi-stellar objects south of declination −33° were found from combined radio and optical observations. (auth)

23549 MODEL FOR THE CENTAURUS X-3 PHENOMENON. Blumenthal, G. R. (American Science and Engineering, Cambridge, Mass.); Cavaliere, A.; Rose, W. K.; Tucker, W. H. Astrophys. J.; 173: No. 1, 213-20(1 Apr 1972).

A model for Cen X-3 is presented according to which the x-ray emission comes from an atmosphere heated by shock waves produced by surface pulsations of a white dwarf. This model can explain the luminosity, period, and spectrum of Cen X-3. The way that these quantities vary with pulsation period and amplitude is discussed. (auth)

23550 PULSAR PARAMETERS FROM TIMING OBSERVATIONS. Manchester, R. N.; Peters, W. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 173: No. 1, 221-6(1 Apr 1972).

Timing observations made over an 18-month interval were used to compute periods, period derivatives, and positions for 19 pulsars. (auth)

23551 DIAMETER OF PKS 1514-24 (AP LIB). Ananthakrishnan, S.; Rao, A. P. (Tata Inst. of Fundamental Research, Ootacamund, India). Nature (London) Phys. Sci.; 235: No. 61, 167(28 Feb 1972).

This radio source, identified with the optical object AP Lib, has aroused considerable interest because of its apparent similarity with the peculiar object BL Lac. The radio variations of BL Lac indicate the presence of an extremely compact radio source, and if AP Lib is similar to BL Lac it is likely that it also has a compact component. Its flat spectrum also suggests the presence of a small diameter component. The best estimate of the diameter of AP Lib so far available was from lunar occulation observations at Ooty, indicating that most of the radio emission originates in a component of diameter ≤0.7 arc S, but the present authors from observations of interplanetary scintillations of AP Lib have found a compact component of ≤0.035 arc S. (UK)

23552 ASYMMETRIES IN COMPACT SOURCES AT 2298 MHz. Legg, A. J. (Weapons Research Establishment, Salisbury, Australia); Gubbay, J. S.; Robertson, D. S.; Nicolson, G. D.; Moffet, A. T. Nature (London) Phys. Sci.; 235: No. 60, 147-9(21 Feb 1972).

Reference is made to interferometer experiments carried out since 1967 over the two intercontinental Depth Space Network baselines Island Lagoon, near Woomere, to Goldstone, California, and Island Lagoon to Johannesburg, with a view to measuring the secular variations on a 0.001 arc S scale of a number of compact sources. Details of the sources that have been viewed over both baselines are tabulated. A surprising finding is that all the stronger sources show higher fringe amplitudes with the trans-Indian Ocean baseline than with the trans-Pacific, and in some cases the amplitude ratio is very large. Some of these fringe amplitude differences cannot be explained as due to baseline length differences or in terms of intensity variations, unless each source has two components varying at equal rates but in opposite senses. There is as yet sufficient evidence to show that there is a preferred direction for the asymmetries, but highly asymmetrical expansion of components seems to be common. (UK)

23553 FURTHER RADIO OBSERVATIONS OF CYGNUS X-1. Braes, L. L. E.; Miley, G. K. (Leiden Observatory). Nature (London) Phys. Sci.; 235: No. 60, 147(21 Feb 1972).

The results are given of continued monitoring of the variability of the Cyg X-1 radio source using the Westerbork synthesis radio telescope at 1415 MHz. Apart from a slight decrease in flux after its initial appearance in April 1971 there was little evidence from the data that the source subsequently varied. The initial estimate of the radio position of Cyg X-1 was also refined, and it seems probable that the radio emission is connected with the HDE star 226868. No indication was found of either the 5.60-day binary period or the 2.98-day x-ray period suggested by other authors. (UK)

23554 PRODUCTION OF A DIFFUSE FLUX OF SOFT X-RAYS BY GALACTIC OBJECTS. Mack, John E. (Univ. of Houston, Tex.). Nature (London) Phys. Sci.; 235: No. 60, 144-6(21 Feb 1972).

The spectrum and intensity of galactic sources of soft x-rays are estimated, and several models of possible sources evaluated. (auth)

23555 AMPLIFIED SPONTANEOUS EMISSION AND OH MOLECULES IN THE INTERSTELLAR MEDIUM. Allen, L.; Peters, G. I. (Univ. of Sussex, Brighton, Eng.). Nature (London) Phys. Sci.; 235: No. 60, 143-4(21 Feb 1972).

Some aspects of the theory of amplified spontaneous emission are stated to yield information relevant to the problem of OH emission in the interstellar medium. In particular, problems of dimensions, intensity, saturation, and line width are discussed (auth)

23556 SPECTRAL INDICES OF RADIO SOURCES SELECTED AT 1.4 GHz. Willson, M. A. G. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 4, 385-94(1972).

Distributions of spectral indices are estimated for samples of extragalactic radio sources in three ranges of flux density at 1400 MHz. It is found that the spectral index distribution is practically independent of flux density down to $S_{1407} = 0.2 \times 10^{-26}$ W m^{-2} Hz^{-1}, but changes significantly at lower flux densities. The faintest sample ($0.01 \leq S_{1407} < 0.2 \times 10^{-26}$ W m^{-2} Hz^{-1}) includes the same proportion of "flat" spectra as the others, but the "normal" spectra are steeper, on average, than those of brighter sources. This steepening may represent the effect of redshift on spectra which are convex at high emitted frequencies. (auth)

23557 CHARACTERISTICS OF SUBPULSES OF PULSAR CP 1133. Alekseev, Yu. I.; Vitkevich, V. V.; Malofeev, V. M. (Lebedev Inst. of Physics, Moscow). Nature (London) Phys. Sci.; 235: No. 61, 167-8(28 Feb 1972).

Amplitude and polarization characteristics of the two subpulses in the radio emission from CP 1133 were compared, using data from the 1000-ft Arecibo telescope at 111, 111.5, and 112 MHZ. Observations were also made using the cross-type radiotelescope DKR 1000 of the Lebedev Physical Institute at 86 MHZ. The histogram for subpulse II showed a second maximum in the tail of the distribution and a deviation from the normal distribution of amplitudes; there was a surplus of subpulses of high amplitude not found for subpulse I. This effect had previously been detected for PP 0943 and AP 0531. The ratio of the average amplitudes of the two pulses was 1.6. Good correlation between the amplitudes of both subpulses at differing observing frequencies suggests a broadband emission process. The power spectrum of the intensity fluctuations was noticeably different for the two subpulses. Polarization measurements at 86 MHZ showed that the subpulses have a high degree of linear polarization, and the orientation of the linear polarization vector of the two subpulses was different and can be close to 90°, while the degree of circular polarization for some subpulses reached 0.5 ± 0.2. The subpulses often show opposite rotation signs. It is concluded that these appear to be two distinct centres of radio emission with highly different parameters. The closeness of these regions having different polarization characteristics suggests that the radio emission is influenced by the local magnetic field of the pulsar and not by the common dipole field. (UK)

23558 RADIOIDENTIFICATIONS OF WEAK EXTRAGALACTIC X-RAY SOURCES. Bridle, A. H.; Feldman, P. A. (Queen's Univ., Kingston, Ont.). Nature (London) Phys. Sci.; 235: No. 61, 168-70(28 Feb 1972).

Radio identifications are proposed for two further sources from the Uhuru satellite catalogue, and it is suggested that they are produced by inverse-Compton losses of electrons that have escaped from radio galaxies. Two 3C sources having "normal" spectral indices above 50 MHz but showing enhanced emission at lower frequencies, both in rich clusters of galaxies, lie within the positional error fields of weak Uhuru sources. The error field of the x-ray source 2 ASE 1144 + 19 contains the radio source 3C 264, related to the bright DE galaxy NGC 3862 in the cluster Abell 1367, while the error field of 2 ASE 0227 + 43 contains the radio source 3C 66, located in the cluster Abell 347. The radio parameters of the low-frequency components of these sources, and the x-ray luminosities implied by the the identifications, are shown tabulated. The identifications suggest that there may be an association between extended radio sources with high spectral indices and extended x-ray sources in clusters of galaxies. A very extended radio source may be produced in a rich cluster of galaxies by accumulation of large numbers of high-energy electrons that escape from the cluster's radio galaxies and then radiate in a weak intracluster magnetic field. It is possible that these clusters will become soft x-ray sources as a result of the inverse-Compton losses of such an accumulation of "leakage electrons". (UK)

23559 STRUCTURE AND KINEMATICS OF THE HII REGIONS M8 AND M20. Bohuski, Thomas Joseph, Jr. Austin, Tex.; Univ. of Texas (1970). 171p. University Microfilms Order No. 72-2304.

Thesis.

Accurate measurements were obtained of the internal motions of two bright H II regions, the Lagoon (M8) and Trifid (M20) Nebulae. Extensive electron densities were also determined from slitless spectra of the [S II]λλ6716, 6731 doublet. The velocity data were obtained with a pressure-scanned Fabry–Perot interferometer. At each location observed in these nebulae, measurements were made of emission lines of Hα, [N II] λ6584, and in some cases of [O III] λ5007. From the evidence provided by radial velocities and the line profiles, no conclusive evidence was found for expansion of either M8 or M20. The electron densities derived from the [S II] intensity ratio show M8 to be centrally condensed while M20 is perhaps slightly so. The densities and temperatures were used to calculate the pressure gradients and then the "gradient ages" of both emission nebulae. The resulting ages are $t \simeq 1.4 \times 10^5$ years for M8 and $t \simeq 3.5 \times 10^4$ years for M20. The apparent youth and the absence of any measurable expansion velocity suggest that M20 is still expanding on a radiative time scale (i.e., with an R-type ionization front). (TSS) (Diss. Abstr. Int., B)

23560 DISTRIBUTION OF LINEAR POLARIZATION IN CASSIOPEIA A AT WAVELENGTHS OF 9.8 AND 11.1 cm. Downs, G. S. (California Inst. of Tech., Pasadena); Thompson, A. R. Astron. J.; 77: No. 2, 120-33(Mar 1972).

Two series of observations of the brightness distribution of the linearly polarized component of the radiation of Cassiopeia A are described. The first was made at a wavelength of 9.8 cm using a two-element interferometer at Stanford which provided a synthesized beamwidth of $1.6 \times 2.7'$. The second set of observations was made with the three-element interferometer of the NRAO at a wavelength of 11.1 cm and a beamwidth of $8.1 \times 9.3''$ was obtained. Because the increments in the antenna spacing of the NRAO interferometer are greater than the critical interval for Cassiopeia A, part of the brightness distribution is missing from the synthesized map at 11.1 cm. This missing component is estimated to contain only 5% of the polarized flux density. The polarized radiation is concentrated in the main bright ring of the source and at 11.1-cm wavelength the maxima in the polarized brightness correspond to ≈5% of the unpolarized radiation. A comparison of the observations with published results at other wavelengths shows that Faraday depolarization reduces the polarized radiation to half the intrinsic value at a wavelength of approximately 7.5 cm. The mean values of the rotation of the position angle of the polarization at a number of points indicate a greater rate of rotation as a function of λ^2 at wavelengths shorter than 6 cm than at longer ones. These data are hardly detailed enough to rule out the possibility of linear rotation with λ^2 but appear to be best interpreted in terms of a nonlinear rotation within the source, together with a linear rotation of about −35 rad m^{-2} which may be attributed to the interstellar medium. The internal rotation can be explained by a model of the source with a radial magnetic field and a thermal electron density of 2 cm^{-3}. The Appendix discusses the effect on synthesis observations of the use of increments in the antenna spacing which are too large. Such undersampling results in the presence of grating lobes, the responses of which can only be separated from the main-beam responses for components of the source of dimensions less than the spacing of the grating lobes. Broader components of the source are lost, and to estimate the flux density of the unconfused main-beam responses it is necessary to correct the brightness scale by a factor derived from the beam pattern. (auth)

23561 RADIO EMISSION FROM SMALL GALACTIC NEBULAE AT 606 MHz. Terzian, Yervant; Pankonin, Vernon (Cornell Univ., Ithaca, N. Y.). Astron. J.; 77: No. 2, 115-19(Mar 1972).

A survey for radio emission from small galactic nebulae is presented at 606 MHz. The observations were made with the 1000-ft

radio telescope of the National Astronomy and Ionosphere Center (Arecibo Observatory). Of the 85 optical nebulae surveyed, 23 were identified to emit radio radiation. Twenty-five other radio sources were also detected close to the positions of the optical nebulae, but could not reliably be identified with the optical objects. The radio spectra of several of the identified nebulae are discussed, and it is indicated that most of them have thermal spectra characteristic of ionized hydrogen clouds. (auth)

23562 DISTANCES OF QUASI-STELLAR RADIO SOURCES. Arakelyan, M. A. Vestn. Akad. Nauk SSSR; No. 11, 26-30 (Nov 1971). (In Russian).

Measurements in 1963 of the redshift of the Balmer series of lines of quasar 3C 273 lead to an estimate of its distance as nearly two billion light years. The difficulties associated with explaining such immense sources of rf power are discussed. The relation between the spatial quasar density and an evolution effect, and other explanations for the observed redshift are summarized. (K.S.W.)

23563 ARE QUASARS LOCAL OR COSMOLOGICAL? Rowan-Robinson, M. (Queen Mary Coll., London). Nature (London); 236: No. 5342, 112-14(17 Mar 1972).

It is stated that the debate about the distances of quasars resembles in many ways the 19th-century debate on nebulae. The solution proposed also resembles that reached for the nebulae. It is proposed that there are two totally different types of objects masquerading under the title of "quasar." In one class the origin of the redshift is cosmological, the optical luminosities range from several hundred times that of a normal galaxy, and the radio luminosities and dimensions are in the range of the strongest radio galaxies. In the second class the cosmological component of the redshift is close to zero and the objects are comparatively local, with some intrinsic redshift mechanism, perhaps gravitational, at work; the optical and radio luminosities of these objects are similar to those of radio-emitting Seyfert nuclei like NGC 1275 or 1068. Separation of quasars into two distinct classes is suggested when their distribution in depth is examined as a function of radio dimensions. (UK)

23564 PULSARS. ter Haar, D. (Oxford Univ.). Phys. Rep.; 3C: No. 2, 57-126(Mar 1972).

A survey is given of various experimental data about pulsars. This is followed by a discussion of attempts to construct theoretical models to account for the observational data. (7 tables, 19 figures, 429 references) (auth)

Solar Phenomena

Refer also to abstract 22846.

23565 BABCOCK'S THEORY OF THE 22-YEAR SOLAR CYCLE AND THE LATITUDE DRIFT OF THE SUNSPOT ZONE. Kopecky, Miloslav (Astronomical Inst., Ondrejov, Czech.). Advan. Astron. Astrophys.; 7: 57-81(1970).

The mathematical form of the determination and expression of Spörer's law permits a qualitative and, to a certain extent, quantitative comparison of theory with observational results, and hence also attempts to modify Babcock's original theory in such a way as to optimally satisfy observations. Various attempts to modify the theory are summarized. (21 references) (W.D.M.)

23566 TYPE III SOLAR RADIO BURSTS. Smith, D. F. (Stanford Univ., Calif.). Advan. Astron. Astrophys.; 7: 147-226 (1970).

A model of the emitting region of a Type III burst is presented, and propagation effects are investigated. The model is based on the theory of nonlinear effects in a plasma at its present stage of development. (100 references) (W.D.M.)

23567 SOLAR ABUNDANCE OF IRON. Ross, John Ernest Ralph. Los Angeles; Univ. of California (1971). 252p. University Microfilms Order No. 72-1503.

Thesis.

The problem of the solar abundance of iron was investigated. The principal difficulty in the determination of the photospheric iron abundance is that the only Fraunhofer lines which have reliable laboratory line strengths (f-values) are "saturated," i.e., an abundance analysis yields the product of abundance, f-value, and a poorly known atomic constant, the "damping constant." The damping constant was studied from a theoretical viewpoint and from an empirical viewpoint. Both studies indicate that the simple formula for the damping constant usually employed underestimates the true damping constant under conditions found in the solar photosphere. Hence, it is expected that the lowest abundance of iron derived from saturated lines, $\{Fe\} = \log N(Fe)/N(H) + 12 \geq 7.4$, should constitute an upper bound to the solar abundance of iron. An attempt was made to extract reliable f-values for "weak" lines, lines which are unaffected by the value of the damping constant, by combining relative f-value data, which are available for lines having a wide range in intensity (or strength), with the well-determined strongline absolute f-value data. There is some suggestion that the relative line strength data are intensity-dependent, in the sense that the weak lines will yield an iron abundance that is too low. Hence, it is expected that the mean abundance of iron derived from weak lines, $\{Fe\} \sim 7.2$, should constitute a lower bound to the solar abundance of iron. The suggested value for the solar photospheric abundance of iron is $\{Fe\} = 7.35 \pm 0.5$, where the uncertainty is not due to scatter in the abundances derived from individual lines, but rather, is due to an uncertainty in choice of analysis. (TSS) (Diss. Abstr. Int., B)

23568 SOLAR DYNAMO THEORY AND THE MODELS OF BABCOCK AND LEIGHTON. Piddington, J. H. (CSIRO, Sydney). Solar Phys.; 22: No. 1, 3-19(Jan 1972).

The dynamo theory of the solar cycle as developed by Parker and others, and the observational models of Babcock and Leighton were examined, with the conclusion that the dynamo theory is not applicable to the Sun and that the models fail. An essential part of the theory is an adequate effective diffusion coefficient. Fields are continuously sheared and amplified and, in this theory, these may not be allowed to accumulate; all subsurface fields of an old cycle must be eliminated. Ohmic diffusion is negligible and turbulent diffusion is invoked. However, this requires that all solar fields are tangled to a small scale, which is contrary to observation; for Hale's polarity laws are strictly observed, and large-scale surface features are common at the end of an 11-yr cycle in the same general area where new fields are appearing. The erupted (sunspot) fields lie generally above the unerupted, toroidal fields so that, even if they are merged as required, the centroid of the new system would be above that of the old. The result is not a steady-state oscillator, as required, but the complete loss of the solar field. It is concluded that for these and other reasons a shallow, reversing field is unacceptable, and that a deeply penetrating field is required. Reference is made to an alternative theory of the solar cycle based on a deep magnetic field. (auth)

23569 TIME VARIATIONS OF THE SOLAR DIFFERENTIAL ROTATION LAW AND ASYMMETRY OF THE GLOBAL DISTRIBUTION OF THE SOLAR ACTIVITY. Yoshimura, Hirokazu (Tokyo Univ.). Solar Phys.; 22: No. 1, 20-33(Jan 1972).

The relation between the systematic time variations of the solar differential rotation at middle latitudes and the asymmetry of global distribution of the solar activity is discussed in connection with the study of the maintenance of the solar differential rotation. The systematic variations at middle latitudes are inferred from a peculiar correlation in the time variations of the solar differential rotation which is shown to be implied in the data of Howard and Harvey (1970) of spectroscopic measurements of rotational velocities. If one adopts the working hypothesis of the solar equatorial acceleration maintained by the angular momentum transport due to the very large scale convection, the two phenomena are related through the concurrent presence of the neighboring modes with the presumed dominant mode of the very large scale convection. (auth)

23570 FINE STRUCTURE OF SOLAR MAGNETIC FIELDS. Zirin, Harold (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Solar Phys.; 22: No. 1, 34-48(Jan 1972).

The deduction of magnetic fields from chromospheric structure is extended to active regions and transverse fields. Fields independently predicted by these rules from a high-resolution Hα filtergram are compared with a high-resolution magnetogram. The Hα method has the advantage over conventional magnetograms that it shows transverse fields and relates the fields to the real Sun. It has the disadvantage that higher spatial resolution is required and that it is difficult and time consuming in very complicated regions. The response of the chromosphere to magnetic fields is most consistent. Vertical field is invariably marked by bright plage, with brightness rougly proportional to the field strength (except for sunspots). All dark fibrils mark transverse fields and are parallel to field lines. All polarity changes are marked by dark fibrils, which may be transverse fibrils perpendicular to the field boundary, or filaments (prominences) which connect more distant points, and in which the field lines run nearly parallel to the boundary. The asymmetry between preceding and following polarity found by Veeder and Zirin (1970) does not exist; it was due to the low resolution of the Mount Wilson magnetograms. The complexity of active region field structure depends on the history of the region; all flux erupts in simple bipolar form, and lines of force remain connected to sibling spots until reconnection takes place. Thus the complex structure only occurs after eruption of several dipoles which re-

connect. The phenomenon of "inverted polarity" turns out to be due to the emergence of satellite bipolar fields, where the p spot merges with the rest of the p field and the f spot appears as an included f field. Flares usually occur when the field lines from f spot reconnect from its sibling to the main spot. (auth)

23571 APPLICABILITY OF GOLDBERG AND UNNO'S METHOD TO THE DETERMINATION OF MICROTURBULENT VELOCITIES IN AN ATMOSPHERE WITH CONVECTION. de Jager, C. (Astronomical Inst., Utrecht); Neven, L. Solar Phys.; 22: No. 1, 49-52(Jan 1972).

The method of Goldberg and Unno for the determination of microturbulent velocities in a stellar atmosphere is only applicable if there are no macroturbulent or convective motions. If such motions occur, as in the solar photosphere, the derived results are false and may lead to misinterpretations such as an increase of the microturbulent velocity with depth or anisotropic microturbulence. (auth)

23572 COMPARISON BETWEEN THE HELIUM 10830 A AND THE HYDROGEN Hα CHROMOSPHERES. Giovanelli, R. G. (CSIRO, Sydney. Kitt Peak National Observatory, Tucson, Ariz.); Hall, D. N. B.; Harvey, J. W. Solar Phys.; 22: No. 1, 53-63 (Jan 1972).

Spectroheliograms of resolution about 2 arc sec obtained simultaneously in He 10830 Å and Hα show in the network a very close agreement in position of dark Hα mottles and of bright Hα plage remnants with 10830 Å absorption, though there is not a one-to-one relation between the intensities; the typical intensity in 10830 Å, corrected for overlapping lines, is $I \approx 0.91$ of the continuum. Some parts of the network do not appear in 10830 Å. This line is much weaker over supergranule centers ($I \approx 0.98$), though near active regions dark Hα fibrils coincide with faint 10830 Å fibrils ($I \approx 0.93$ to 0.98). (auth)

23573 REMARKS ON THE CONVERGENCY OF PHOTOSPHERIC MODEL CONCEPTIONS AND THE SOLAR QUASI CONTINUUM. Labs, Dietrich (Landessternwarte, Heidelberg); Neckel, Heinz. Solar Phys.; 22: No. 1, 64-9(Jan 1972).

A comparison was made of the observed intensity in the solar continuous spectrum with those predicted by some models. Arguments are given that the bend-off observed for $\lambda < 0.6\ \mu$ is a real phenomenon, and due to a veiled line haze. (auth)

23574 SEMI-EMPIRICAL SOLAR LINE BLANKETING. II. THE RESULTS OF BLANKETING IN SOLAR MODEL ATMOSPHERES. Mutschlecner, J. P. (Indiana Univ., Bloomington); Keller, Charles F. Solar Phys.; 22: No. 1, 70-87(Jan 1972).

The line blanketing procedure described in an earlier paper has been tested by a series of blanketed solar model atmosphere calculations incorporating methodological and data variations. The results of those tests show the method to be reasonably insensitive to data uncertainties and to certain assumptions employed. The method was also checked by calculating several blanketed stellar atmospheres for comparison with blanketed atmospheres computed by other investigators. Except at the highest atmospheric levels the comparisons of the model structures were good and the blanketing method appears to be validated. (W.D.M.)

23575 ANALYSIS OF CORONAL ENHANCEMENTS THROUGH SOME RECENT SPECTROSCOPIC ACHIEVEMENTS OF MONOCHROMATIC EMISSIONS OF IRON IONS (Fe X TO Fe XV). Rozelot, J. P. (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France). Solar Phys.; 22: No. 1, 88-113(Jan 1972). (In French).

Solution of the classical equations of statistical equilibrium for each of the ions led to a system of linear equations and gives the values of the relative populations of the various energy levels. This enables one to study the behavior of numerous spectral lines, including the six observed forbidden lines, as functions of temperature and electron density. A possible explanation can be given of some anomalies found in the behavior of FeX, indicator of young active centers. A strong correlation between the intensity of Fe XI and Fe XIV indicates high temperature regions. Fe XIII is on the contrary a sensitive indicator of strong electronic density regions. The case of Fe XII is discussed apart. Arguments are given for the inflow of matter into coronal enhancements, derived from the study of isoratio curves of the intensity, for two values of the dilution factor. Indications for fluctuations in temperature and density are found at about 1.1 $R_\odot$. The fluctuations occur mainly in the young phase of development of the corresponding active centers. The incorporation of the effect of diffusion of heavy elements gives a good fit between theory and observation at altitudes between 60,000 and 90,000 km. The observed fluctuations of the intensities are better explained in terms of electronic density variations than of those of the temperature. The nonuniformity of temperature and density is studied along the line of sight: if at a constant temperature the density varies, the inhomogeneities in the density are always smaller than 10%. It is shown that along the line of sight a gaussian distribution of the density, together with a bi-squared variation of the temperature best fits the observations. (auth)

23576 NOTE ON THE HELIUM-LIKE ION LINE EMISSION IN SOLAR PLASMAS. Mewe, R. (Astronomical Inst., Utrecht). Solar Phys.; 22: No. 1, 114-18(Jan 1972).

An analysis is presented of the rate coefficients occurring in the Gabriel–Jordan theory on the relative intensities of the forbidden, intercombination, and resonance lines of helium-like ions in a steady-state plasma. Simple expressions are given to show the dependence on atomic number and electron temperature. The influence of proton collisions on the excitation $2^3S \rightarrow 2^3P$ is estimated and deviations from the theory under nonequilibrium conditions are briefly discussed. (auth)

23577 CROSSOVER AND MAGNETO-OPTICAL EFFECTS IN SUNSPOT SPECTRA. Grigor'ev, V. M.; Katz, J. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Irkutsk, USSR). Solar Phys.; 22: No. 1, 119-28(Jan 1972).

Two peculiarities of the magnetic splitting of lines in sunspot spectra were investigated. The first one consists of the fact that in a rather small region of the penumbra, near the umbra–penumbra boundary, the π component is absent in the spectra of one circular polarization while both σ components are present. In the spectra of the opposite circular polarization, the σ components are absent but the π component is present. By analogy with the magnetic stars, in whose spectra such an effect was observed by Babcock, this phenomenon was called the "crossover effect" in the sunspot spectra. Some properties of this effect in the different spectral lines were investigated. The nature of this effect is discussed. The second peculiarity consists of the anomalous splitting of the π component of Zeeman triplets which are of the same and opposite signs in comparison with splitting of the σ components. The different possibilities of explanation are discussed. (auth)

23578 FINE STRUCTURE OF THE EVERSHED EFFECT. Mamadazimov, M. (Pulkovo Observatory, USSR). Solar Phys.; 22: No. 1, 129-36(Jan 1972).

The fine structure of the Evershed effect was studied using spectrograms obtained on July 3, 1969 at the Pulkovo Observatory. The results of the study of Fe I and Ca I lines show that the outward motion in the penumbra is concentrated only in dark filaments. It is supposed that interfilamentary spaces are parts of the photosphere not covered by dark filaments. The velocity variation along a few dark filaments shows that maximum velocity is at a distance 0.8 $R_\odot$ from the center of the sunspot. The mean velocity in the interfilamentary elements is of the same order as that in the photosphere directly adjoining the penumbra. The results of measurement in Ti II, Fe II, and CH lines show that in the colder upper part of the penumbra (CH) the velocity is greater than the velocity measured in the deeper layers (Fe II and Ti II). The mean velocity at the outer boundaries of the dark filaments (Ti I) is 1.5 to 2.0 km/s. (auth)

23579 MAGNETIC FIELDS IN UMBRAL ATMOSPHERES UNDER SIMILARITY CONFIGURATION. Yun, Hong Sik (Franklin Inst., Swarthmore, Pa.). Solar Phys.; 22: No. 1, 137-9(Jan 1972).

An attempt is made to obtain a relatively refined magnetic model of a spot in order to capitalize on the improvement of the theory of line formation in the presence of the magnetic field. (W.D.M.)

23580 OBSERVATION OF A SMOKE RING ON OCTOBER 30, 1970. Kawaguchi, Ichiro; Oda, Nobuyuki; Mizuno, Shun (Univ. of Kyoto, Japan). Solar Phys.; 22: No. 1, 140-1(Jan 1972).

At the Okayama Astrophysical Observatory a smoke or vortex ring was observed at 128° on the solar limb. The behavior of the prominence from which the smoke ring was formed was very peculiar. The prominence activity is briefly discussed. (W.D.M.)

23581 QUIET-SUN CENTER-LIMB OBSERVATIONS AT 6 AND 11 cm DURING CYCLE MAXIMUM. Ceballos, J. C.; Lantos, P. (Meudon Observatory, France). Solar Phys.; 22: No. 1, 142-6(Jan 1972).

Simultaneous 6- and 11-cm maps of the quiet Sun were obtained with the Nançay radio telescope during the 1968–69 cycle maximum. (auth)

23582 PENCIL BEAM OBSERVATION OF A LARGE MICROWAVE OUTBURST AT 94.8 GHz. Cogdell, J. R. (Univ. of Texas, Austin). Solar Phys.; 22: No. 1, 147-9(Jan 1972).

On March 27, 1969, at about 1326 UT an impulsive burst was observed for approximately one hour, during which 12 scans were made, at a frequency of 94.8 GHz, with the 16-ft radiotelescope at

Fort Davis, Texas. The data were taken with a pencil beam antenna of 151′′ beamwidth. (W.D.M.)

23583 RESULTS FROM OSO-IV: THE LONG TERM BEHAVIOR OF X-RAY EMITTING REGIONS. Krieger, A.; Paolini, F.; Vaiana, G. S.; Webb, D. (American Science and Engineering, Cambridge, Mass.). Solar Phys.; 22: No. 1, 150-77(Jan 1972).

A grazing-incidence x-ray telescope on board the OSO-IV spacecraft obtained images of the Sun in the 2.5- to 12-Å waveband nearly continuously from October 27, 1967 to May 12, 1968. The instrument had sufficient spatial resolution (one and four arc minutes) and temporal resolution (5 to 20 min) to estimate the spatial characteristics of x-ray emitting regions and to monitor the temporal behavior of individual active regions. Variations in the absence of flares of as much as a factor of 10 in the x-ray output of individual regions were observed, with typical durations ranging from several hours to several days. The x-ray time variations are related to observations at optical and radio wavelengths. The results are interpreted under the assumption that the x-ray time variations are caused by temperature changes in the coronal portions of active regions. The contribution of radiative losses to the energy budget of the coronal active region is estimated. (auth)

23584 HEATING OF THE SOLAR-FLARE PLASMA BY HIGH ENERGY ELECTRONS. Cheng, Chung-chieh (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 22: No. 1, 178-88(Jan 1972).

Heating of the ambient plasma by high-energy electrons in solar flares is discussed. It is shown that for large flares the heating is enough to produce a thermal plasma of a temperature up to a few times of 10^7 K rapidly in the initial phase of the flares. Thus, thermal bremsstrahlung in addition to nonthermal bremsstrahlung should be considered for the x-ray emission of solar flares in the initial phase. (auth)

23585 RELATIVISTIC ELECTRONS FROM THE SUN OBSERVED BY IMP-4. Simnett, G. M. (Univ. of California, Riverside). Solar Phys.; 22: No. 1, 189-219(Jan 1972).

Data are presented from the IMP-4 satellite of 0.3- to 12-MeV electrons from the Sun between May 24, 1967 and May 2, 1969. Correlations with contemporary proton intensity increases at energies above 1 MeV are studied. Categories of unusual events are defined and examples of each type are given. Discussion of these events centers around the emission and propagation of energetic particles from the point of origin on the Sun to the Earth. (W.D.M.)

23586 ENHANCED ABUNDANCES OF LOW-ENERGY HEAVY ELEMENTS IN SOLAR COSMIC RAYS. Lanzerotti, L. J. (Bell Telephone Labs., Murray Hill, N. J.); Maclennan, C. G.; Graedel, T. E. Astrophys. J.; 173: No. 1, L39-43(1 Apr 1972).

Measurements of solar cosmic-ray O/He, Si/He, and Fe/He ratios during the onset phase of the Jan. 25, 1971 flare event indicate a substantial (20 to 40 times) enhancement of the ratios above the solar photospheric abundances. It is suggested that preferential acceleration of the heavy elements within the solar-flare region is the most likely cause of the increased abundances. (auth)

23587 ALFVEN WAVE PROPAGATION IN INTERPLANETARY SPACE. Daily, William Dean, Jr. Provo, Utah; Brigham Young Univ. (1971). 136p. University Microfilms Order No. 72-1754.

Thesis.

A dispersion equation is derived for propagation of plasma waves in a nonuniform external magnetic field. Its solution assumes that, when the field is inhomogeneous, only first-order small changes will occur in the wave parameters and the guiding-center approximation is used to calculate these changes. The equations are applied to the problem of Alfven-wave propagation in interplanetary space from longitudinal gradients in the external field and numerical solutions are presented. (Diss. Abstr. Int., B)

23588 FAST NEUTRONS IN THE ATMOSPHERE DURING PERIODS OF SOLAR ACTIVITY. Light, Edward S. New York; New York Univ. (1971). 226p. University Microfilms Order No. 72-3094.

Thesis.

The effects of solar activity upon the neutron production in the atmosphere were studied. In 1968 and 1969, during the enhanced solar activity around the time of solar maximum, a series of atmospheric measurements of the fast neutron flux was conducted at polar latitudes. Data were obtained during particle events and Forbush-type decreases in June, October, and November 1968, and February through April 1969, as well as in undisturbed periods. The quiet-time data in this series of airplane measurements were consistent with data from balloon flights in the same period. As expected, neutron fluxes at the transition maximum were more sensitive to changes in the primary cosmic-ray spectrum, typically by a factor of about three, than were the sea level neutron monitors. A Monte Carlo simulation of the internuclear cascade in the atmosphere was performed to compare with experimental results as well as to provide the low-energy neutron distribution, neutron leakage flux, and ^{14}C production. The calculated results are compared with the experiments reported here, those of others, and other calculations. The effects of different incoming cosmic-ray spectra on the atmospheric neutrons are also displayed. (Diss. Abstr. Int., B)

23589 ISOPHOTOMETRY OF THE CHROMOSPHERIC BRIGHT AND DARK MOTTLES ON THE SOLAR DISK. Alissandrakis, C. E.; Macris, C. J. (Research Center for Astronomy and Applied Mathematics, Athens). Astrophys. Lett.; 10: No. 2, 59-60(Feb 1972).

An isophote map of bright and dark mottles at the center of Hα is given. The relative positions of the mottles are discussed. (auth)

23590 COSMIC AND SOLAR SYSTEM ABUNDANCES OF DEUTERIUM AND ^{3}He. Geiss, J. (Univ., Bern); Reeves, H. Astron. Astrophys.; 18: No. 1, 126-32(Apr 1972).

From analysis of solar and solar wind abundances it is concluded that the D/H ratio in the protosolar gas was much smaller than it is found in ocean water or carbonaceous chondrites. Best estimates for the protosolar gas are $D/H = 2.5 \times 10^{-5}$ and $He/H \lesssim 10^{-5}$. Isotopic enrichment of deuterium is thought to have occurred in the solar nebula prior to or during accretion of planetary bodies, mainly as a result of chemical reactions of hydrogen with oxygen and other elements. Chemical equilibrium reactions at low temperature actually lead to large D enrichment, in agreement with the conclusion derived from solar data. The D and ^{3}He abundances in the protosolar gas are consistent with a Big Bang origin of these nuclei, corresponding to a universal baryonic density of 3×10^{-31} g/cm^3 (deceleration parameter $q_0 \approx 10^{-2}$) and zero leptonic number. (auth)

23591 SOLAR CURVE OF GROWTH OF IRON. Foy, R. (Observatoire, Meudon, France). Astron. Astrophys.; 18: No. 1, 26-38(Apr 1972).

A solar curve of growth of iron was constructed using new oscillator strengths now available in the literature. This curve of growth shows that its damping part is unquestionably split into several branches, each of them corresponding to a different value of the damping constant. The intrinsic scatter on the damping constants is shown to alter the curve of growth even for lines of moderate strengths. Therefore it is necessary especially for dwarf stars where the damping constant is large, to read the abscissa of a line on the curve of growth having the appropriate damping constant and not on an average curve of growth. Taking this into account results in modifying the values of the iron abundance and the microturbulence velocity in the solar photosphere. Different correlations between damping and other parameters—as parity of multiplets, excitation potentials of the levels of the transitions, quantum numbers J and L—are discussed. It is found that the damping chiefly depends upon the excitation potentials, and not upon the parity of the multiplets. Furthermore, a meaningful scatter in the damping constants among lines of single multiplet is observed. (auth)

23592 ZEEMAN SPLITTING IN SOME BRIGHT PROMINENCES. Wiehr, E. (Univ., Goettingen, Ger.). Astron. Astrophys.; 18: No. 1, 79-81(Apr 1972).

The Zeeman splitting of the Mg b_2, Na D_2, and Ca^+ 8542 lines in several bright prominences was determined photographically with λ/4 plate and Wollaston prism. Application of an image intensifier allowed exposure times of the order of a few seconds in spite of high spectral resolution of about 3.5×10^5. The resulting field strengths did not exceed significantly the error limits of ±150 gauss in agreement with previous polarimetric measurements. The recently reported strong prominence magnetic fields of $H \approx 1500$ gauss measured photographically with low resolution and without image intensifier were not observed. (auth)

23593 LINE PROFILES IN SUNSPOTS. Kneer, F. (Fraunhofer-Institut, Freiburg i. B.). Astron. Astrophys.; 18: No. 1, 39-46(Apr 1972). (In German).

Photoelectric measurements of the brightness ratio spot/photosphere at the wavelengths 5131 and 6222 Å, as well as the profiles of three magnetically unaffected Fe I lines (5123.7, 5434.5, and 5576.1 Å) obtained from high-resolution photographic spectra are given. The observations are corrected for the influence of stray light obtained through extrapolation of the aureole intensity measured photoelectrically. A hydrostatic model for the umbra is adjusted to the observations, which is in a good agreement with the model given by Stellmacher and Wiehr (1970). Since the wings of

the Fe lines used depend only weakly upon the pressure, the latter is uncertain within a factor of 2. Therefore, by the given observations, small departures from hydrostatic equilibrium cannot be excluded. The amount of microturbulence turns out to be ≦1 km/s, that of macroturbulence ≈1 km/s. (auth)

23594 PROFILES OF MAGNETICALLY SPLIT LINES IN SUNSPOTS. Kneer, F. (Fraunhofer-Institut, Freiburg 1. B.). Astron. Astrophys.; 18: No. 1, 47-50(Apr 1972). (In German).

The gradient of the magnetic field dH/dh in sunspot umbrae was determined from profiles of magnetically split lines. For this purpose 17 line profiles in the range 6200 to 6300 Å were selected from spectra of the main spot of the group 5454 (Rome number) taken on June 12 and 13, 1969. The profiles were corrected for scattered light after Kneer (1972). The magnetic field strength was determined for each line by fitting calculated intensity profiles to the measured ones. It was assumed that the magnetic field strength is valid for some average height in which the line profile is formed. The gradient of the magnetic field strength was found to be 0.4 (±0.6) gauss/km. Furthermore, the line profiles indicated macroturbulent motions with $v \approx 1$ km/s and very small microturbulent velocities. (auth)

23595 PHOTOIONIZATION CROSS-SECTIONS FOR ATOMS AND IONS OF ALUMINUM, SILICON, AND ARGON. Chapman, Robert D. (Goddard Space Flight Center, Greenbelt, Md.); Henry, Ronald J. W. Astrophys. J.; 173: No. 1, 243-5(1 Apr 1972).

Photoionization cross-sections for all levels belonging to configurations $1s^2 2s^2 2p^6 3s^2 3p^q$, $q > 0$, of atoms and ions of aluminum, silicon, and argon were calculated using Hartree–Fock bound-electron wave functions and close-coupling approximation free-electron wave functions. The results are presented in the form of a computationally convenient interpolation formula. (auth)

23596 THEORETICAL STUDY OF FORMATION OF PROMINENCES. Hildner III, Ernest Gotthold. Boulder, Colo.; Univ. of Colorado (1971). 209p. University Microfilms Order No. 72-3662.

Thesis.

Numerical computations are presented for the formation of quiescent solar prominences by condensation from the solar corona. The governing equations for one- and two-dimensional geometries are integrated to obtain solutions that describe the condensation of model coronal material to a cooler, denser state. A fluid approach to the coronal material is taken throughout, except for cooling due to electromagnetic radiation. In all computations, the coronal fluid is assumed to be completely ionized hydrogen, optically thin at all wavelengths, with infinite electrical and zero thermal conductivity. The fluid is assumed to be initially in hydrostatic equilibrium and in thermal balance (heating equal to cooling). This is, the energy function (heating due to mechanical processes minus cooling due to electromagnetic radiation) is zero. If, in the initial state of thermal balance, the isobaric derivative of the energy function with respect to temperature is positive, then a density perturbation of the initial state can result in a condensation (Field 1965). (TSS) (Diss. Abstr. Int., B)

23597 INTERPRETATION OF TOTAL LINE INTENSITIES FROM OPTICALLY THIN GASES. I. A GENERAL METHOD. Jefferies, J. T. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.); Orrall, F. Q.; Zirker, J. B. Solar Phys.; 22: No. 2, 307-16(Feb 1972).

A general method is described for inferring, from the line emission of an optically thin medium, the physical state of the gas along the column in the line of sight which is sampled by the observations. Since it is not possible to infer the distribution of the physical state parameters with position in the line of sight—any arbitrary rearrangement of material giving equivalent line emission—instead another way was sought to specify the state. A unique specification is found in terms of the bivariate distribution function $\mu(n,T)$, describing the partitioning of the matter in the gas over the density and temperature. It is shown that, given sufficient observational data, it is in principle possible to determine both $\mu(n,T)$, and the chemical composition. With less complete data the acuity of the analysis is correspondingly reduced. The method is devised for application to the astronomical case, especially for studies of the solar corona, the chromosphere–corona transition region, planetary nebulae, and other optically thin sources. The formulation is illustrated for the situation encountered in the solar corona. (auth)

23598 INTERPRETATION OF TOTAL LINE INTENSITIES FROM OPTICALLY THIN GASES. II. THE CORONAL FORBIDDEN LINES. Jefferies, J. T. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.); Orrall, F. Q.; Zirker, J. B. Solar Phys.; 22: No. 2, 317-26(Feb 1972).

The application of a general diagnostic procedure to the inference of the physical state of coronal condensations from a knowledge of their forbidden line emission is discussed. The limitations set on such an analysis by inadequacies in existing data are considered and the additional observations in the infrared and ultraviolet, as well as the visible, which will be needed for development of the full power of the diagnostic method are indicated. (auth)

23599 INTERPRETATION OF TOTAL LINE INTENSITIES FROM OPTICALLY THIN GASES. III. APPLICATION TO CORONAL FORBIDDEN LINE SPECTRA. Jefferies, J. T. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.); Orrall, F. Q.; Zirker, J. B. Solar Phys.; 22: No. 2, 327-43(Feb 1972).

The diagnostic method developed in the two preceding papers of this series is applied to coronal forbidden-line intensity data obtained at eclipses in 1952, 1961, 1965, 1966, and 1970. The application of the method is limited by the nature of the data but allows a first inference of the relationship between electron density and temperature in the condensations observed at these eclipses, and of the distribution of the electrons within the temperature range samples by the observations—effectively 10^6 to 2.4×10^6 K. The relative abundance of nickel to iron in the corona was determined; a value in agreement with latest photospheric determinations and with a similar (factor of two) uncertainty. Lower limits were set to the abundance of iron with respect to hydrogen; values consistent with recent photospheric determinations. (auth)

23600 FORMATION OF THE SOLAR Hα PROFILE. Schoolman, Stephen A. (Lockheed Solar Observatory, Rye Canyon, Calif.). Solar Phys.; 22: No. 2, 344-57(Feb 1972).

A series of non-LTE radiative transfer solutions for Hα was computed using the integro-differential equation technique of Athay and Skumanich (1967). A model hydrogen atom consisting of three bound levels and a continuum was assumed. It was found that increasing the temperature of the chromosphere at the height of line formation decreases the central intensity of the line. The density structure of the atmosphere primarily affects the optical depth scale rather than the source function. The temperature minimum region of the atmosphere was found to be transparent to Hα radiation, so that the radiation in some part of the line will arise from two distinct layers of the atmosphere, one above the temperature minimum and one below it. The computed Hα profile was found to be highly sensitive to the assumed 2–3 collisional cross section. (auth)

23601 INHOMOGENEOUS STRUCTURE OF THE SOLAR CHROMOSPHERE FROM LYMAN-CONTINUUM DATA. Vernazza, J. E. (Harvard Coll. Observatory, Cambridge, Mass.); Noyes, R. W. Solar Phys.; 22: No. 2, 358-74(Feb 1972).

A new model of the chromosphere is described, based on Lyman-continuum observations by Harvard spectrometers aboard the satellites OSO 4 and OSO 6. The model assumes (a) that a random distribution of optically thick inhomogeneities overlies a plane-parallel homogeneous atmosphere, and (b) that the Lyman continuum in the chromosphere is optically thick and the only significant opacity source between 600 and 912 Å. The temperature, gas pressure, electron pressure, particle densities, and b_1 (the hydrogen ground-state departure coefficient) are calculated as a function of height in the chromosphere. The model reproduces the observed quiet-region intensities in the Lyman continuum. The inhomogeneous structures, believed to be spicules, are inferred to be optically thick in the Lyman continuum and to have a source function below that of the mean chromosphere. If they are also optically thick in the free–free (millimeter) continuum and cooler than about 5000°K, they could produce the observed limb darkening at 1 and 3 mm. Such low temperatures are at odds with current spicule models, but could exist in the cores of spicules. The Lyman-continuum emission shortward of 750 Å shows an excess emission over that predicted by the above model. This is found to be consistent with the existence of a temperature plateau with $T \sim 22000$°K in the very high chromosphere. (auth)

23602 MULTI-COMPONENT MODELS FOR THE FORMATION OF THE CHROMOSPHERIC Ca II K LINE. II. THE EFFECT OF VELOCITY FIELDS. Cram, L. E. (Univ. of Sydney). Solar Phys.; 22: No. 2, 375-86(Feb 1972).

Recent high-resolution observations of the Ca II fine structure are discussed. An analytic method is applied to examine the effects of velocity fields on multicomponent model atmospheres in which the central reversal in the bright components is due to self-absorption. It is shown that the inclusion of quite-reasonable velocity fields permits the reproduction of not only the high-resolution profiles of the small-scale emission features but also the qualitative center-limb behavior of the spatially averaged profiles. The method is also used to examine models suggested by Pasachoff and others in which the double reversal is a statistical effect of singly peaked velocity shifted profiles. These models are shown to encounter severe difficulties near the limb. (auth)

23603 MODEL FOR THE CHROMOSPHERE-CORONA TRANSITION REGION BASED ON RADIO OBSERVATIONS AND ON HYDRODYNAMICAL CONSERVATION EQUATIONS. Lantos, P. (Meudon Observatory, France). Solar Phys.; 22: No. 2, 387-401 (Feb 1972).

In order to avoid the disagreements and difficulties now found in the interpretation of quiet-Sun uv observations concerning the chromosphere–corona transition region, 6- and 11-cm maps obtained at cycle maximum with the Nançay radiotelescope were used in combination with existing measurements of the central brightness temperatures at centimetric wavelengths and with the hydrodynamic conservation equations so as to obtain an equatorial, quiet solar atmosphere model between 10,000 and 300,000°K, in the interspicular regions. This model introduces a large ascending velocity in these regions. Some of the consequences of the model concerning the heating and replenishment of the corona are discussed. An explanation of sudden disappearance of quiescent prominences is suggested. (auth)

23604 FILAMENTARY NATURE OF SOLAR MAGNETIC FIELDS. Howard, Robert (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Stenflo, J. O. Solar Phys.; 22: No. 2, 402-17(Feb 1972).

A method is presented for obtaining information about the unresolved filamentary structure of solar magnetic fields. A comparison is made of pairs of Mount Wilson magnetograph recordings made in the two spectral lines Fe I 5250 Å and Fe I 5233 Å obtained on 26 different days. Due to line weakenings and saturation in the magnetic filaments, the apparent field strengths measured in the 5250-Å line are too low, while the 5233-Å line is expected to give essentially correct results. From a comparison between the apparent field strengths and fluxes and their center-to-limb variations, the following tentative conclusions were drawn: (a) more than 90% of the total flux seen with a 17 by 17 arc sec magnetograph aperture is channeled through narrow filaments with very high field strengths in plages and at the boundaries of supergranular cells; (b) an upper limit for the interfilamentary field strength integrated over the same aperture seems to be about 3 G; (c) the field lines in a filament are confined in a very small region in the photosphere but spread out very rapidly higher up in the atmosphere; and (d) all earlier Mount Wilson magnetograph data should be multiplied by a factor that is about 1.8 at the center of the disk and decreased toward the limb in order to give the correct value of the longitudinal magnetic field averaged over the scanning aperture. (auth)

23605 MEAN PHOTOSPHERIC MAGNETIC FIELD FROM SOLAR MAGNETOGRAMS: COMPARISONS WITH THE INTERPLANETARY MAGNETIC FIELD. Scherrer, Philip H. (Univ. of California, Berkeley); Wilcox, John M.; Howard, Robert. Solar Phys.; 22: No. 2, 418-24(Feb 1972).

Large-scale averages of daily solar magnetograms were compared by cross-correlation with the interplanetary magnetic sector pattern during a 2.5-yr interval. A significant correlation was found at a lag of about 4.5 days, with the amplitude of the correlation depending on the area included in the magnetogram averages. The highest correlation was found when an area of one quarter of the solar disk was used, consistent with the idea that the photospheric features to be associated with the interplanetary sector pattern are large-scale features. (auth)

23606 SUPPRESSION OF THE KINK INSTABILITY FOR MAGNETIC FLUX ROPES IN THE CHROMOSPHERE. Raadu, M. A. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 22: No. 2, 425-33(Feb 1972).

Energy storage in chromospheric flux ropes is discussed in the context of solar flares. The structure is represented by a cylindrically symmetric magnetic field of finite length. The field is assumed to be approximately force-free. The stability of the field to a kink perturbation is investigated. Flux ropes are rooted in dense photospheric material. So the ends of the field lines are taken to be fixed on rigid boundaries for all perturbations. An energy perturbation method is used and the boundary conditions give a stabilizing effect. It is shown that for a moderate degree of twisting the fields are stable to a kink perturbation. Thus energy can be stored in cylindrical fields prior to release in a solar flare. (auth)

23607 ALFVEN WAVES IN UMBRAL FLUX TUBES. Wilson, P. R. (Univ. of Sydney). Solar Phys.; 22: No. 2, 434-42 (Feb 1972).

Savage (1969) has suggested that an energy flux of 2×10^{10} erg cm^{-2} s^{-1} passes through the umbra of a sunspot in the form of hydromagnetic waves. Some of the consequences of this flux are considered. It is first shown that it is not inconsistent with the energy requirements for the heating of umbral dots and for solar-wind storms, assuming in the latter case that the flux tubes emerging from about one tenth of the area of a large spot are open-ended. However, the hypothesis also requires that Alfvén waves travel along the closed flux tubes linking the umbra either with the umbra of another spot or with the surrounding faculae and passing through regions of variable field strength and density. It is shown that, for a very simplified model, standing waves are possible in a symmetrical field configuration. For velocities of 3 km/s in the umbra, the maximum particle velocity in the loop is of order 80 km/s which strains the perturbation assumption severely. However, it is pointed out that periodic velocities of this order are observed in the chromosphere near sunspots. It is further shown that mechanical dissipation of these waves in local regions of the flux tube may contribute to the heating of faculae. (auth)

23608 DIFFERENTIAL ROTATION AND THE STRUCTURE AND ENERGY CONTENT OF CORONAL MAGNETIC FIELDS. Raadu, M. A. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 22: No. 2, 443-9(Feb 1972).

It is argued that differential rotation of the photospheric magnetic fields will induce currents in the corona. The work done against surface magnetic stresses will increase the energy content of the coronal magnetic field. The electrical conductivities are high and the foot points of field lines move with the differential rotation. The force-free field equations are solved with this constraint to obtain a minimum estimate of the energy increase for a quadrupole field. During a solar rotation the magnetic energy increases by 25%. Local release of this energy in the corona would have a significant effect. The expansion of field lines as a result of the differential rotation should increase the amount of flux and the field strength in the solar-wind region. (auth)

23609 OBSERVED HEIGHTS OF EUV LINES FORMED IN THE TRANSITION ZONE AND CORONA. Simon, George W. (Sacramento Peak Observatory, Sunspot, M. Mex.); Noyes, Robert W. Solar Phys.; 22: No. 2, 450-8(Feb 1972).

The heights of formation of a number of extreme-ultraviolet lines in active regions were measured from OSO-IV spectroheliograms. Using the Lyman continuum at 2000 km above the white light limb as a reference, heights were found for He I, He II, C III, N III, O IV, O VI, Ne VIII, Mg X, Si XII, Fe XV, and Fe XVI that were in approximate agreement with models based on analysis of euv emission intensities. The height of C II was anomalously high. The accuracy of measurement was typically about 2000 km. The data suggest that the transition zone is less steep than calculated from euv emission intensities; however, higher-resolution observations are necessary to resolve the discrepancy. (auth)

23610 CALCULATED SOLAR X-RADIATION FROM 1 TO 60 A. Mewe, R. (Astronomical Inst., Utrecht). Solar Phys.; 22: No. 2, 459-91(Feb 1972).

The fluxes of about 230 spectral lines in the range 1 to 60 Å from coronal ions of C, N, O, Ne, Na, Mg, Al, Si, S, Ar, K, Ca, Ti, Cr, Mn, Fe, and Ni were computed for a range of electron temperature from 10^5 to 10^{9}°K. The relative ion abundances were derived from Jordan's ionization equilibrium calculations. The continuum emission was derived from computations of Landini and Monsignori Fossi with a correction for the free–free emission. (7 tables, 3 figs., 78 references) (auth)

23611 NORMALIZATION OF SOLAR X-RAY DATA FROM MANY EXPERIMENTS. Wende, Charles D. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 22: No. 2, 492-502(Feb 1972).

A conversion factor is used to convert Geiger (GM) tube count rates or ion chamber currents into units of the incident x-ray energy flux in a specified passband. A method is described which varies the passband to optimize these conversion factors such that they are relatively independent of the spectrum of the incident photons. This method was applied to GM tubes flown on Explorers 33 and 35 and Mariner 5 and to ion chambers flown on OSO 3 and OGO 4. Revised conversion factors and passbands are presented, and the resulting absolute solar x-ray fluxes based on these are shown to improve the agreement between the various experiments. Calculations have shown that, although the GM tubes on Explorer 33 viewed the Sun off-axis, the effective passband did not change appreciably, and the simple normalization of the count rates to the count rates of a similar GM tube on Explorer 35 was justified. It is also shown that for the type 6213 GM tube, the passband is effectively 3 to 12 Å although gas pressure and window thickness variations may give rise to numerical conversion factor differences of a factor of 6. (auth)

23612 NUMBER OF SPOTGROUPS FORMED AND THEIR AVERAGE LIFETIME IN SOLAR ACTIVITY CYCLE NO. 19. Kopecky, M. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 1, 55-60(1972).

This paper complements the values of the number of formed sunspot groups and their average lifetimes published earlier. It is shown that the very high value of the Wolf number in cycle No. 19 is a product of superimposing the 80-year period of the mean spotgroup's lifetime and the very long secular variation of the number of new formed spotgroups. (auth)

23613 DYNAMICS OF THE SOLAR PROMINENCES. I. KINEMATICS OF THE SOLAR PROMINENCE OF 10 SEPTEMBER 1956. Palus, P. (Komensky Univ., Bratislava). Bull. Astron. Inst. Czech.; 23: No. 1, 60-8(1972).

A special type of solar prominence was studied, namely the AS type, according to the Menzel–Evans classifications. The motion of the knot shows a spiral pattern. The analysis of the data showed that a hyperbolic spiral on a cone surface is the best approximation to the observed motion. (auth)

23614 FLARE-ASSOCIATED SOLAR-WIND DISTURBANCES AND TYPE II AND IVm RADIO BURSTS. Pinter, S. (Geophysical Inst., Hurbanovo, Czech.). Bull. Astron. Inst. Czech.; 23: No. 1, 69-75(1972).

The relations between flare-associated solar wind disturbances and Type II and IVm radio bursts are considered. The flare-associated solar wind disturbances were observed by means of different satellites between 1965 and 1969. The observed characteristics of the solar wind are: the proton density and the flow velocity. The kinetic energy of the flow was computed from these values for the individual flare-associated disturbances of the solar wind. It was found that the kinetic energy of the "post-shock" flow is proportional to the overall flux of the radio emission at 200 MHz, which is defined by the smooth flux density multiplied by the duration of the IVm-Type burst. It was also found that the energy of the interplanetary shock wave is roughly proportional to the energy of the IVm-Type burst. These mutual relations indicate the close connection between the respective emission mechanisms. The relations between the interplanetary shock wave and the II and IVm-Type bursts are explained by means of a flare mechanism, suggested by Křivský (1968). The occurrence of combined Type-II and -IVm-Type bursts indicate that the shock wave moves in front of a plasma cloud through the solar corona and, given sufficient energy, it is capable of propagating into interplanetary space, where it can be observed as a shock wave causing magnetic storms at a distance of 1 AU. (auth)

23615 EFFECT OF DIFFERENTIAL REFRACTION AND DIFFERENTIAL EXTINCTION ON CORONAL OBSERVATIONS. Rusin, V. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 23: No. 1, 75-82(1972).

As mentioned by Sýkora (1971), among many other errors in observing the intensities of coronal lines there are also differential refraction and differential extinction. The analysis of coronal observations made at the observatories of Pic du Midi and Lomnický Štit does not prove the effects mentioned above uniquely. It was found that the errors due to the observational method and photometry were larger. (auth)

23616 DIRECTIONAL DEPENDENCE OF THE EMISSION OF ACOUSTIC NOISE BY CONVECTIVE TURBULENCE IN A GRAVITATIONAL ATMOSPHERE. Kuperus, M. (Astronomical Inst., Utrecht). Solar Phys.; 22: No. 2, 257-62(Feb 1972).

The directional dependence of the emission of sound waves in the solar atmosphere was studied. It is shown that quadrupole acoustic radiation generated in convective turbulence is strongly enhanced in the direction of the mean convective flow. The intensity in a direction θ with the convective velocity is proportional to $(1 - M_c \cos\theta)^{-7/2}$, where M_c is the Mach number of the convective motion. The influence of the atmospheric cutoff frequency on the transmitted acoustic spectrum is taken into account. It is suggested that low-frequency atmospheric oscillations may modulate the flux of high-frequency sound waves. (auth)

23617 SOME PROPERTIES OF VELOCITY FIELDS IN THE SOLAR PHOTOSPHERE. IV. LONG PERIODS, FIVE MINUTE OSCILLATIONS, AND THE SUPERGRANULATION AT LOWER LAYERS. Deubner, Franz-Ludwig (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys.; 22: No. 2, 263-75 (Feb 1972).

Photoelectric measurements of photospheric velocity fields were carried out with the Sacramento Peak Doppler Zeeman analyzer. Emphasis was given to long periods and low spatial wave numbers in deep photospheric layers, where the 5-min oscillations are less dominant. Multiple or double peaks cannot be detected in power spectra of the 5-min oscillations, provided that a sufficient number of physically independent points on the solar surface are observed. The most frequent "wave numbers" in the spectra of 5-min oscillations (as well as of the low-frequency field) agree with those derived from a model assuming statistically independent oscillators of 10 to 20" diameter. These two velocity fields are anti-correlated spatially. Kinetic power in the 20- to 50-min range of periods is closely linked to brightness changes in the same layer, an increase of brightness lagging about 250 sec behind rising motion. Granules can be excluded as a possible source for the appearance of low-frequency flow patterns. Different explanations are suggested. (auth)

23618 SPECTRAL ANALYSES OF SOLAR PHOTOSPHERIC FLUCTUATIONS. I. POWER, COHERENCE AND PHASE SPECTRA CALCULATED BY FAST-FOURIER-TRANSFORM TECHNIQUES. Edmonds, Frank N. Jr.; Webb, Carol J. (Univ. of Texas, Austin). Solar Phys.; 22: No. 2, 276-96(Feb 1972).

The application of the fast-Fourier-transform (FFT) algorithm to calculating one-dimensional and bi-dimensional (temporal and spatial), power and cross-power (coherence and phase) spectra was examined for solar photospheric fluctuations. Alternative methods for smoothing raw spectra, direct averaging (employing various weights) and indirect truncation of the correlation function, were compared, and indirect smoothing was compared with spectra calculated by mean-lagged-product (MLP) methods. Besides providing the raw spectrum, FFT techniques easily allow computing a series of spectra with varying amounts of smoothing. From these spectra a range of satisfactory compromise between resolution and stability can be determined which helps in the interpretation of spectral trends, and in identifying more clearly the existence and significance of spectral features. For bi-dimensional spectra presented as contour plots, this range of satisfactory smoothing can be restricted, particularly when spectral trends must be represented by small-scale contours. Equivalent spectra (i.e., comparable equivalent degrees of freedom) computed or smoothed by different methods have minor, but not negligible, differences. Examination of these differences favors computing of FFT spectra smoothed by averaging for photospheric fluctuations. (auth)

23619 TURBULENT VELOCITY IN UNDISTURBED AND ACTIVE PHOTOSHPERE. Badalyan, O. G. (Moscow State Univ.); Livshits, M. A. Solar Phys.; 22: No. 2, 297-306(Feb 1972).

Profiles of weak Fraunhofer lines were recorded photoelectrically in both the faculae and the undisturbed photosphere. The entrance slit of the double-pass spectrograph corresponded to $1 \times 20''$ on the solar disk. Turbulent velocities were found by comparing half-widths of the observed profiles with those of model calculations. These latter were carried out with aid of an electronic computer for the Bilderberg Continuum Atmosphere (BCA) under the assumption of true absorption and depth independent turbulent velocities. Line-formation levels were derived from the contribution curves computed by the method of weighting functions. For the undisturbed photosphere a turbulent velocity of about 2.6 km/s was found with no appreciable increase with the depth. In facular filaments all lines formed above $\tau = 0.1$ showed smaller turbulence velocities, the velocity differences being in the range between 0.2 and 0.6 km/s. (auth)

23620 SOLAR NON-THERMAL RADIO EMISSIONS IN THE ABSENCE OF FLARES. Martres, M. J. (Observatoire, Paris); Pick, M.; Soru-Escaut, I.; Axisa, F. Nature (London) Phys. Sci.; 236: No. 63, 25-7(13 Mar 1972).

Observations are described that indicate an association between some isolated groups of metric Type III bursts and transient Doppler-shifted Hα absorbing features in the solar chromosphere, and acceleration or release of fast charged particles by chromospheric phenomena in the absence of flares is suggested; these phenomena may be active prominences or surges. Examples are considered for which spectrographic data confirm the Type III nature of the bursts, and a number of cases of confirmed Type III bursts were observed that were clearly associated with transient Hα absorbing features in the chromosphere; no flare was in progress in the same solar region at the time of these observations. Some common features shown by the Type III bursts are discussed. The results show that some coronal nonthermal radio emissions can occur in the absence of visible flares and in association with perturbations affecting the chromosphere. (UK)

Galaxies

Refer also to abstracts 23528, 23640, and 23989.

23621 COMPACT AND DISPERSED COSMIC MATTER. PART II. Zwicky, F. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Advan. Astron. Astrophys.; 7: 227-83(1970).

Topics discussed include the search for new cosmic objects and phenomena, nature of the redshift from compact galaxies, and future projects. (86 references) (W.D.M.)

23622 POSSIBLE EVIDENCE FOR AN INTERGALACTIC MEDIUM IN CLUSTERS OF GALAXIES. De Young, D. S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 173: No. 1, L7-11(1 Apr 1972).

An initial list of 64 simple double radio sources was examined to determine if any morphological differences exist between those sources that lie within clusters of galaxies and those that lie without. After elimination of possible selection effects, the remaining list of 34 sources was investigated for differences in component separation and ratio of component size to separation. The mean-component separation for those sources not in clusters of galaxies was slightly more than twice the mean separation for sources in clusters, and the mean size-to-separation ratio for sources outside clusters was about 0.6 the mean of those inside. It is argued that this may be due to the presence of a significant amount of intergalactic gas in clusters of galaxies. (auth)

23623 X-RAY FLUX VARIATIONS FROM M87. Cavallo, G.; Messina, A. (Laboratorio di Technologie e Studio delle Radiazioni Exstraterrestri, Bologna). Astrophys. Lett.; 10: No. 2, 61-5(Feb 1972).

The hypothesis that the x-ray flux variations of M87 are due to supernova outbursts occurring in the Virgo Cluster is shown to be consistent with the observations. Intrinsic x-ray luminosity, total energy emitted in x rays, and outburst rate can then be expressed as functions of the single parameter τ, the x-ray emission decay time. Reasonable values are obtained for $\tau \simeq 15$ days and $\tau \simeq 30$ days. The last value would suggest that mostly Type I supernovae are responsible for this x-ray emission. It is unlikely that supernovae make a substantial contribution to the diffuse x-ray background. (auth)

23624 NEUTRAL HYDROGEN SELF-ABSORPTION IN A LARGE REGION TOWARD THE GALACTIC CENTER. Riegel, Kurt W.; Crutcher, Richard M. (Univ. of California, Los Angeles). Astron. Astrophys.; 18: No. 1, 55-69(Apr 1972).

A large region of the galactic plane, covering the longitude range 345 to 25° and the latitude range ±6° was surveyed in the 21-cm spectral line. Most of the area surveyed was found to contain a very prominent H I self-absorbing cloud. Optical depths are of order unity in some directions in the cloud, and the physical temperature of the medium must be low, of the order 20°K. The cold cloud consists of multiple components of cold material with a complicated velocity structure. The strongest component is at a radial velocity of about +7 km/s with respect to the LSR, with other components at about +4 and 0 km/s. Over most of the cloud, these components are quite distinct, and have different distributions in l and b; however, in one region the +7 and +4 components coalesce in radial velocity. The cold material forming the cloud is within about 900 pc of the Sun. If the distance is large, toward the high end of this range, typical H I density in the cloud is less than about 0.1 cm^{-3}, which might suggest that the material is part of the interarm medium. If so, the conclusions would differ from those derived from other observational data on the interarm medium, and with some theoretical work on the characteristics of the interarm and intercloud medium suggesting higher temperatures. Implications might be (a) strong confinement of low-energy cosmic rays to the spiral arms, (b) no depletion of heavy elements coolants by adsorption onto interstellar dust grains, (c) that the high- and low-temperature extremes in the interstellar medium are more disparate than heretofore assumed. On the other hand, the true distance might be smaller, on the order of 100 pc. A smaller distance would imply a larger, more normal H I density of ≈ 0.5 cm^{-3} and would make the cloud a local feature of our spiral arm. To a limit of 0.1°K there does not appear to be any normal OH emission, such as that found associated with interstellar dust, connected with the cold cloud. Nor does there appear to be any H_2CO or CO. Detailed comparisons with optically observed dust clouds do not indicate any convincing correlation between features on the H I optical depth maps and the dust. All of this evidence points to the cold H I cloud as an H I feature deficient in dust and molecules. (auth)

23625 21-cm LINE STUDY OF THE HEAVILY OBSCURED GALAXY IC 10. Bottinelli, L.; Gouguenheim, L.; Heidmann, J. (Observatoire, Meudon, France). Astron. Astrophys.; 18: No. 1, 121-5(Apr 1972).

The heavily obscured galaxy IC 10 was observed in the 21-cm line of neutral hydrogen with the Nançay radio telescope and the neutral hydrogen diameter was measured along the east–west direction. Using a statistical relation between the H I diameter and the optical one, an apparent optical diameter of about 17′ was deduced. This result suggests that the optical diameter was previously underestimated by a factor of 2 or 3 because of strong galactic absorption. The distance of IC 10 was estimated to be (2.9 ± 1.5) Mpc. This value locates IC 10 outside the Local Group of galaxies and quite close to the Maffei galaxies with which it may form a group. A latitude–velocity diagram indicates that the galaxies in the UMa–Cam cloud and in the Local Group may constitute a chain or an elongated complex of galaxies. (auth)

23626 CORRELATION BETWEEN THE INTRINSIC RADIO-POWER AND THE SPECTRAL INDEX OF RADIO GALAXIES. Veron, M. P. (Observatoire, Meudon, France); Veron, P.; Witzel, A. Astron. Astrophys.; 18: No. 1, 82-91(Apr 1972).

It has been found by several authors that there is a statistical trend for radio galaxies with a high monochromatic intrinsic power to have a steeper spectral index. It is shown that, if the sample is restricted to "elliptical radio galaxies", that is elliptical galaxies identified with a radio source with two or more components, none of them being associated with the nucleus of the galaxy, there is a good correlation between the two above mentioned parameters. This correlation is interpreted as an evolutionary track, the spectrum of radio galaxies becoming flatter when the power decreases. A theory by Ginzburg and Syrovatskii (1968) gives a qualitative description of this evolution. The radio galaxies with curved and steep spectra may be old sources which depart from the "main sequence". This correlation holds for quasars which have a radio structure similar to that of "elliptical radiogalaxies" and may be used to get a rough figure of the redshift of radio sources using only radio properties, once their spectra and radio structure are known. (auth)

23627 VERTEX DEVIATION. Mayor, M. (Observatoire, Geneva). Astron. Astrophys.; 18: No. 1, 97-105(Apr 1972).

The kinematic properties of different stellar samples are discussed. A more plausible interpretation of the deviation of the vertex is sought: reflection of initial conditions or nonaxisymmetrical perturbation of the potential. The slow decrease observed for the deviation of the vertex relatively to the mean eccentricity of the stellar samples excludes the interpretation based solely on a reflection of initial conditions. On the other hand the kinematic consequences of a corotating local perturbation are considered. Since such a perturbation could be the Orion arm, the field of vertex deviation for a population of A stars moving in the perturbed potential is looked for. (auth)

23628 SPECTROSCOPIC STUDY OF THE IRREGULAR GALAXY NGC 3067. Danziger, I. J.; Chromey, F. R. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. Lett.; 10: No. 3, 99-104(Mar 1972).

A spectroscopic analysis of the Type II Irregular galaxy NGC 3067 shows it to have an interstellar gas component of low density. Rotation curves give a mass of 1.8×10^{10} $M_\odot$ in the inner one third of the visible galaxy. A mass density of 1.5 $M_\odot$ pc^{-3} is higher than average, but the mass-to-luminosity ratio, 6.8, and the absolute visual magnitude, −19.2, are consistent with mean values quoted for Type II Irregular galaxies. (auth)

23629 INTERFEROMETRIC STUDIES OF INTERSTELLAR CALCIUM LINES. Marschall, Laurence A.; Hobbs, L. M. Yerkes Observatory, Williams Bay, Wis.). (Astrophys. J.; 173: No. 1, 43-62(1 Apr 1972).

Interferometric, photoelectric scans of the interstellar calcium K lines in the spectra of 65 stars are presented. The scans were obtained with a PEPSIOS spectrometer having a passband with a full half-intensity width of 1.0 km s^{-1} or 0.013 Å. The fivefold improvement in resolution over that used by Adams reveals numerous line components that correspond very well to those of the interstellar sodium lines, apart from frequent differences in relative intensities. (auth)

23630 OBSERVATIONAL APPROACH TO THE PROBLEM OF SPIRAL STRUCTURE. II. Dixon, M. E.; Ford, V. L. (Australian National Univ., Canberra). Astrophys. J.; 173: No. 1, 35-42(1 Apr 1972).

The spatial distributions of "old" and "young" stars in the vicinity of the major arm of the Large Magellanic Cloud are compared in order to determine whether or not the major arm is a wavelike feature that propagates smoothly through the interstellar gases in the azimuthal direction. Present results apply to the R(2.2, 4.1) kpc radial zone and indicate that the major arm is not propagating smoothly through the interstellar gases at the present epoch. The ($M_v < -3.5$) stars at the inner and outer edges of the arm have approximately the same age; and the only regular age progression that is evident in the distribution of these stars is directed along rather than across the arm. An examination of 21-cm radial-velocity data indicates that, in the outer (R > 2.8 kpc) parts of the LMC, the interstellar gases move in approximately circular orbits and stream into the major arm along its leading edge. (auth)

23631 INFERENCES FROM THE COMPOSITION OF TWO DWARF BLUE GALAXIES. Searle, Leonard; Sargent, Wallace

L. W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 173: No. 1, 25-33 (1 Apr 1972).

The emission spectra of two dwarf compact galaxies, I Zw 18 and II Zw 40, which were earlier described as "isolated extragalactic H II regions," were analyzed. Oxygen and neon have lower abundances (relative to hydrogen) than does the interstellar gas near the Sun, while helium has a normal abundance. These galaxies are the first metal-poor systems of Population I to be discovered: the normal helium abundance is taken as evidence that this abundance is primordial. It is shown that most of the mass in I Zw 18 and II Zw 40 is probably in the form of interstellar hydrogen gas. The observed colors were used with the composition data to infer that the present rate of star formation exceeds the past average rate. It is argued that the galaxies are either young (in the sense that most of their star formation has occurred in recent times) or that the star formation in them occurs in intense bursts which are separated by long quiescent periods. A statistical search for objects in the quiescent phase is suggested as a means of distinguishing between the two possibilities. (auth)

23632 SPECTRA OF 80 GALAXIES IN MARKARIAN'S SECOND LIST AND THE SPACE DENSITY OF THE MARKARIAN GALAXIES. Sargent, Wallace L. W. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 173: No. 1, 7-24(1 Apr 1972).

Low-dispersion spectroscopic observations were made of 80 objects in Markarian's second list of galaxies with an abnormally strong ultraviolet continuum. Redshifts were measured for 68 objects which included one bright quasi-stellar object (Markarian 132), which has $z_{em} = 1.75$ and a rich absorption-line spectrum, and 62 emission-line galaxies. These included four galaxies of the Seyfert type (Nos. 79, 106, 124, and 176) and six members of a class of dwarf galaxies with strong, high-excitation, emission lines described by Sargent and Searle. Markarian's first three lists contain 302 objects, distributed over 2000 square degrees of the sky. It is shown that the lists are reasonably complete down to $m_p = 15.5$ while at $m_p = 16.5$ they are incomplete by a factor of about 5. Redshifts obtained by various authors were used to derive absolute magnitudes M_p for 61 out of 70 galaxies in list I and for 94 out of 130 in list II. Down to $m_p = 15.5$ redshifts are available for 109 out of 125 galaxies in these two lists. The V/V_m method devised by Schmidt was used to determine the incompleteness factor for galaxies with $m_p \leq 15.5$ and to show that it does not vary significantly with M_p. The data were then used to derive the space density $\Phi(M_p)$, in units of Mpc^{-2} per unit magnitude interval, for Markarian galaxies with $-13 \geq M_p \geq -22$. The results are given in a table and are compared with estimates of $\Phi(M_p)$ for field galaxies. In particular it is shown that the dwarf emission-line galaxies have a space density of about 10^{-2} Mpc^{-3} mag^{-1} at $M_p = -14$ while luminous Seyfert galaxies have $\log \Phi(M_p) = -5.7$ at $M_p = -21$. Some consequences of these estimates of space density are discussed. (auth)

23633 POSSIBLE ORIGIN OF THE HIGH-VELOCITY NEUTRAL HYDROGEN GASES. Chow, T. L. (Stanislaus State Coll., Turlock, Calif.); Savedoff, M. P. Nuovo Cim.; 8B: No. 1, 130-42 (11 Mar 1972).

Using the modified-characteristic method, the consequences when high-momentum extragalactic clouds collide with galactic gases are calculated. Both variable density and radiation loss are included hydrodynamically. The results show that most of the high-velocity neutral hydrogen gases may result from recombination after the galactic post-shock gas radiates its surplus energy. (auth)

23634 STABILITY PROBLEM OF OSCILLATIONS ALONG THE AXIS OF SYMMETRY IN A GALAXY. III. LYAPUNOV'S LINEAR THEORY AND A GENERALIZATION OF THE RESULTS. Andrle, P. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech.; 23: No. 1, 40-7(1972).

The stability problem of oscillations along the axis of symmetry in a galaxy was studied by determining the first order perturbations in previous papers (Andrle, 1969a,b, 1970). Those results are generalized by using Lyapunov's qualitative method in order to study the stability of the solutions. These solutions correspond to a simple form of oscillations and they lead to Hill's differential equation. Two particular solutions of Hill's equation are found and a sufficient condition for the instability was derived in a simple form. The validity of the results obtained from the special case mentioned above is extended to a more general case corresponding to a set of disturbed oscillations. (auth)

Cosmology

Refer also to abstracts 23590, 23918, 23967, 23996–24000, 24004, and 24083.

23635 IMPROVING THE HUBBLE DIAGRAM FOR COSMOLOGY IN THE 1970s. Spinrad, H. (Univ. of California, Berkeley). Comments Astrophys. Space Phys.; 3: No. 6, 168-72(Nov-Dec 1971).

The extension and improvement of the Hubble diagram for distant objects seems an important—perhaps the most important—possible advance in observational cosmology in the next few years. Some of the requirements to improve the diagram are discussed. (W.D.M.)

23636 TWO OLD COSMOLOGICAL TESTS. Peebles, P. J. E. (Princeton Univ., N. J.). Comments Astrophys. Space Phys.; 3: No. 6, 173-8(Nov-Dec 1971).

In 1935 Hubble and Tolman discussed two possible tests of the new expanding cosmology of Friedmann and Lemaitre. Both the Hubble and Tolman tests now seem ripe for reconsideration as probes for the question, what is the Universe like in the large scale. (W.D.M.)

23637 PARTICLE CREATION BY GRAVITATIONAL FIELDS IN COLLAPSE AND SINGULARITY. Zeldovich, Ya. B. Comments Astrophys. Space Phys.; 3: No. 6, 179-84(Nov-Dec 1971).

Particle creation can occur only in strong and rapidly changing gravitational fields. The two places these conditions occur are in gravitational collapse of heavy stars and in the initial cosmological singularity. Mechanisms for particle creation are discussed. (W.D.M.)

23638 COVARIANT CHRONOGEOMETRY AND EXTREME DISTANCES. I. Segal, I. (Univ. of Copenhagen. Univ. of Lund, Sweden). Astron. Astrophys.; 18: No. 1, 143-8(Apr 1972).

A space-time model is proposed which is locally identical with Minkowski space in its geometrical and causality features, but globally distinct. Its physical implications are effectively identical with those of Minkowski space at classical distances, but are materially different as regards cosmology and the classification of elementary particles. In particular, the model implies a non-Doppler redshift and other cosmological features; these are in satisfactory agreement with observation. (auth)

23639 DYNAMIC MOTIONS IN THE EARLY UNIVERSE. Chernin, A. D. (Ioffe Inst. of Physics and Tech., Leningrad). Astrophys. Lett.; 10: No. 3, 125-8(Mar 1972).

Dynamic motions on space scales approaching the Friedmann radius can generate rotating and nonrotating condensations in protogalactic matter. The condensations separate from the expanding metagalactic medium when the mean density of the Universe becomes comparable to the present interior density of galaxies. (auth)

23640 CONDITIONS FOR THE RAPID GROWTH OF PERTURBATIONS IN AN EXPANDING UNIVERSE. Saslaw, William C. (Univ. of Virginia, Charlottesville). Astrophys. J.; 173: No. 1, 1-5(1 Apr 1972).

The relation, originally derived by Bonnor, which governs the growth of spherical perturbations in an isotropic universe is shown to apply also to expanding anisotropic world models which may rotate. New solutions of this equation are found in which perturbations can grow exponentially. If the background density decreases as $\rho \sim t^{-2}$ and the present value of $\rho^{\frac{1}{2}}t$ is at least a factor 3 greater than the highest conventional value, then galaxies can form from $\sqrt{N}$ statistical fluctuations at a redshift $z \approx 1500$. This would not be compatible with standard models of general relativity, but it would be consistent with present observations. (auth)

23641 REDSHIFTS VERSUS APPARENT MAGNITUDES FOR CLUSTERS OF GALAXIES. McVittie, G. C. (Univ. of Illinois, Urbana). Mon. Notic. Roy. Astron. Soc.; 155: No. 4, 425-34 (1972).

An attempt is made to reconstitute the apparent magnitudes (V_c) of the brightest members of clusters of galaxies from the available information. The redshifts of the clusters being denoted by z, it is argued that the only empirical, and statistically significant, conclusion is that $V_c - 5 \log z$ is constant for 39 clusters with redshifts in the range $0 < z < 0.461$. The main purpose is to describe a theoretical method for finding the parameters of zero-pressure uniform models of the Universe when the empirical conclusion is accepted. (auth)

23642 REDSHIFT–MAGNITUDE RELATION IN HIERARCHICAL COSMOLOGIES. Haggerty, Michael J.; Wertz, James R. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 155: No. 4, 495-503(1972).

The usual redshift–magnitude relation is valid when the expansion rate of the Universe, though time-dependent, is uniform. Modifications due to larger-scale clustering are suggested. They are based on a model of light propagation in which light moves at a constant velocity with respect to the mean motion of the matter through which it passes. Specific results are obtained which could serve as a potential test of big-bang hierarchical cosmological models. In such models there is in general a scale-dependence of the Hubble parameter. The main effect of this scale dependence would be to make current estimates of the deceleration parameter larger than the true values. Thus, present observational data could be made consistent with small or negative values of the true deceleration parameter, q_0 — and, in particular, with the value $q_0 = -1$ associated with the steady-state model. (auth)

23643 DIRAC PARTICLES AND GEOMETRODYNAMICAL CHARGE IN CURVED GEOMETRIES. Unruh, William George. Princeton, N. J.; Princeton Univ. (1971). 99p. University Microfilms Order No. 72-2755.

Thesis.

This thesis consists of two essentially different sections, the first discussing the Dirac particle with its nonclassical spin, in a gravitational field, and the second discussing the possibility of defining a geometrical analog to electric charge. The theory of the Dirac electron in a curved geometry is briefly developed, and then used to investigate the behavior of a Dirac particle near a Schwarzschild black hole. Special attention is paid to the probability of absorption by the black hole in the limits of very small and very large black hole masses. The metastable energy levels and level widths are calculated in the limit as the mass of the black hole goes to zero. It is found that the absorption coefficients and level widths display marked dependence on not only the value of the orbital angular momentum, but also on the total angular momentum. The importance of the spin-gravitational field interaction is thus strikingly displayed. It is also shown that, in the limit of small Schwarzschild masses, the probability of absorption by the hole falls to zero for all angular momenta of the particle. The question of the existence of a geometrical analog to electric charge is discussed. Such an analog is defined in terms of the integral of an exact differential form, which depends covariantly on the metric tensor alone. It is shown that, to fourth order in the derivatives of the Riemann tensor, no such quantities exist, in either the empty space, the Einstein–Maxwell space, or the arbitrary matter space (no field equations restricting the metric). It is also shown that in the arbitrary matter space, the only possible geometrodynamical charges are generalization of the Misner–Finkelstein conserved quantities. (Diss. Abstr. Int., B)

23644 SUGGESTED CONCEPT FOR GALAXY-CLUSTER SIZE FOR USE IN THE ANGULAR-SIZE COSMOLOGICAL TEST. Noonan, Thomas W. (State Coll., Brockport, N. Y.). Astron. J.; 77: No. 2, 134-7(Mar 1972).

The mean distance of cluster members from the line of sight through the cluster center is suggested as a suitable radius for clusters of galaxies in using the cosmological test of angular size versus redshift. (auth)

23645 INFALL OF MATTER IN GALAXIES. Larson, Richard B. (Yale Univ., New Haven). Nature (London); 236: No. 5340, 21-3(3 Mar 1972).

Arguments based on the existence of intergalactic matter are advanced to show that this matter may interact with and be accreted by galaxies to produce observable consequences. The diversity of the phenomena that results from such processes offers a possible understanding of some of the properties of extragalactic systems. (auth)

Planetary Phenomena

23646 CHEMICAL AND SPECTROGRAPHIC ANALYSES OF LUNAR SAMPLES FROM APOLLO 12 MISSION. Annell, C. S.; Carron, M. K.; Christian, R. P.; (and others). U. S., Geol. Surv., Prof. Pap.; No. 750-C, 179-81(1971).

Seven samples of lunar material returned by the Apollo 12 mission were analyzed by semimicro chemical, x-ray fluorescence, and optical emission spectrographic methods for their major-, minor-, and trace-element content. The Apollo 12 materials are notably lower in TiO_2 content (≈ 3%) than are the Apollo 11 igneous rocks (≈ 9 to 14%). Trace-element variations between igneous rock samples from Apollo 12 reflect their greater diversity in texture and modal mineralogy. (auth)

23647 SEMIMICRO ANALYSIS OF APOLLO 12 LUNAR SAMPLES. Rose, H. J. Jr.; Cuttitta, Frank; Annell, C. S.; (and others). U. S., Geol. Surv., Prof. Pap.; No. 750-C, 182-4(1971).

The major-, minor-, and trace-element composition of two igneous rocks and four fines was determined by combined semimicro chemical, x-ray, fluorescence, and spectrographic methods. The samples collected by the Apollo 12 mission at the Ocean of Storms have a higher refractory-element content and lower volatile-element content than comparable terrestrial rocks. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

23648 ELECTRODYNAMIC DRIFT IN THE NOCTURNAL F-REGION IONOSPHERE CAUSED BY CONJUGATE POINT SUNRISE. Carlson, H. C. Jr.; Walker, James C. G. (Yale Univ., New Haven). Planet. Space Sci.; 20: No. 2, 141-8(Feb 1972).

A rapid change in the electrical conductivity of the ionosphere occurs at the time of sunrise. When the conjugate point is in darkness, this change causes a change in the component of the dynamo electrostatic field normal to the sunrise line, and this change in electrostatic field should cause a corresponding change in the vertical component of ion-drift velocities in the F region. The theory developed predicts changes in ion-drift velocities that are of the same order of magnitude (tens of meters per second) as the dynamo-region winds. The effect may be detectable as an upward or downward movement of the nocturnal ionosphere at the time of conjugate point sunrise. (auth)

23649 LOW ENERGY ELECTRON PRECIPITATION AND THE IONOSPHERIC F-REGION IN AND NORTH OF THE AURORAL ZONE. Evans, D. S. (Goddard Space Flight Center, Greenbelt, Md.); Jacobsen, T.; Maehlum, B. N.; Skovli, G.; Wedde, T. Planet. Space Sci.; 20: No. 2, 233-51(Feb 1972).

A low elevation sounding rocket (Polar 1) was used in the exploration of the F-region morphology in and north of the auroral zone over Northern Norway. The rocket that moved over a horizontal distance of some 400 km inside the F region, monitored low-energy electron precipitation and various upper atmosphere excitation and ionization processes. The latitudinal variations of the less than 1 keV energy electron fluxes showed excellent agreement with corresponding variations in the F-region electron density and the OI (λ6300Å) emission below the rocket, indicating that the low-energy electrons are the main sources for these phenomena at these high latitudes. An N_2^+ (λ4278Å) arc was located near the decrease in the 40 keV energy electron fluxes. This arc was produced by a nearly monoenergetic influx of some 3 keV energy electrons. The expected luminosity profile derived from this energy spectrum differs significantly from that observed, and possible explanations for the discrepancy are discussed. (auth)

23650 COSMIC NOISE ABSORPTION STUDIES AT DELHI OVER A SOLAR CYCLE. Sarma, S. B. S. S.; Sharma, M. C. (National Physical Lab., New Delhi). Planet. Space Sci.; 20: No. 2, 253-9(Feb 1972).

Results of cosmic-noise absorption studies for the period 1957 to 1966 over Delhi are presented. A new method was adopted to derive the unattenuated cosmic noise intensity over a sidereal day (QDC) that is believed to be an improvement over previous methods. Absorption shows a strong diurnal, seasonal, and solar-cycle variation. There is a strong dependence of total absorption on f_0F2 and the F region seems to contribute a large portion towards the total absorption. For the same f_0F2 the absorption shows a minimum during summer. There is a strong correlation between the total electron content and the total absorption. The absorption measurements at 20 and 30 MHz are consistent with an inverse-frequency-square law dependence. Simultaneous measurements by A_1 and A_2 techniques have been utilized in separating the absorption contribution for the different ionospheric layers reliably. (auth)

23651 NONUNIFORM ENTRY OF SOLAR PROTONS INTO THE POLAR CAP. Scholer, M.; Haeusler, B.; Hovestadt, D. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Planet. Space Sci.; 20: No. 2, 271-83(Feb 1972).

Observations of the temporal and spatial behavior of energetic solar protons are presented for the solar proton event that began on March 6, 1970. The data were obtained on the polar orbiting satellite GRS-A/AZUR by means of two particle telescopes and two omnidirectional detectors. The latitude intensity structure of several north polar passes was examined in detail. Differences in the fluxes of low energy protons of up to a factor of 8 were observed between the central polar cap and the low-latitude region of the polar cap. The results are compared with interplanetary proton flux and magnetic-field measurements obtained by the HEOS A1 satellite. It is suggested that low energy solar protons enter the low latitude polar cap via quasi-trapped trajectories and in addition by pitch-angle scattering. The high latitude region is reached via the distant magnetotail. The influence of the interplanetary-field conditions on the access is examined. (auth)

23652 FREQUENCY OF PULSATING AURORA AND ITS RELATIONSHIP TO OTHER CHARACTERISTIC PARAMETERS. Brekke, A. (Auroral Observatory, Tromso, Norway). Planet. Space Sci.; 20: No. 2, 285-9(Feb 1972).

Some comments are offered on the paper by Moore (Planet. Space Sci., 19: 119(1971)) in which an inverse relationship was reported between the delay time of the [O I] emission at 5577 Å relative to the N_2^+ emission at 3914 Å and the frequency of the pulsating aurora, and in which, based on quenching theory, a relationship was calculated between the effective lifetime of the metastable $O(^1S)$ atoms from which the [O I] line is emitted and the auroral altitude, leading to the conclusion that the frequency of the pulsating aurora is height-dependent. It is pointed out that an inverse relationship between the delay time for the [O I] emission relative to the N_2^+ emission and frequency does not involve the same relationship between the effective lifetime of the $O(^1S)$ atoms and the frequency, since the effective lifetime and the delay time are not physically the same parameter. The relationship between the effective lifetime of the $O(^1S)$ atoms and phase angle between the circular frequency components for the two emissions was investigated more closely from measurements made in Tromso during the 1967–70 winter. The relationship found by Johensen (Planet. Space Sci., 14: 217(1966)) between the frequency and the deduced parameter $C_0 = A/I_n^{\frac{1}{2}}$ was also examined [I_n is the mean intensity in kR of the N_2^+ emission at 4278 Å and A is the auroral absorption of cosmic radio noise in dB]. In the Tromso measurements a two-channel photometer pointing towards zenith was employed, and for observations of auroral absorption a riometer tuned for 27.6 MHz was used. Results are detailed and discussed. (UK)

23653 SPREADING OF A PROTON BEAM BY THE ATMOSPHERE. Johnstone, A. D. (Univ. of Alaska, College). Planet. Space Sci.; 20: No. 2, 292-5(Feb 1972).

An approximate expression for the spreading by charge exchange of a fine proton beam precipitating into the atmosphere is obtained. It shows the dependence on atmospheric structure, collision data, primary particle energy, and pitch angle in a simple way. (auth)

23654 ZENITH ANGLE DEPENDENCE OF THE GEOCORONAL LYMAN-ALPHA GLOW. Paresce, F.; Kumar, S.; Bowyer, S. (Univ. of California, Berkeley). Planet. Space Sci.; 20: No. 2, 297-9(Feb 1972).

Observations on the zenith angle dependence and intensity of the geocoronal hydrogen L–α glow were made using a xuv photometer flown on a rocket launched from Thumba, India on March 10, 1970. Details are given of the apparatus and experimental technique. The altitude dependence of the data on both the up- and down-leg of the flight was consistent with that expected from resonantly scattered Lyman-α radiation absorbed by O_2. The intensity of the Lyman-α glow at 215 km versus the zenith angle of the center of the field of view of the detector is shown graphically; similar results were obtained at altitudes up to 264 km. The results provided experimental verification of the theoretical predictions of Meier and Mange (Plant. Space Sci., 18: 803(1970)). Measurements of the actual zenith intensity were, however, much higher than the theoretical predictions of those authors, and possible reasons for this are discussed. It is thought possible that the intensity of the L–α glow was, in fact, much higher, and hypotheses to explain changes in the intensity are discussed. (UK)

23655 INFRASONIC PRESSURE DISTURBANCE STUDY OF TWO POLAR SUBSTORMS. Johnson, R. E. (Univ. of Alaska, College). Planet. Space Sci.; 20: No. 3, 313-29(Mar 1972).

Infrasonic pressure disturbances generated during the growth and decay of two polar substorms of October 31, 1968 were studied, utilizing pressure records from four stations spanning continental North America. Spatial and temporal changes of the magnetic substorm are represented by contour maps of the total horizontal disturbance vector over the course of the substorms. Correlation with all-sky camera photographs shows that a reversal in direction of motion of the luminous aurora may follow poleward expansions, which then generate infrasonic pressure disturbances into the lower atmosphere. As the substorm develops the pressure disturbances are generated by multiple sources and travel by multiple paths, while becoming distorted by interference processes among themselves during propagation. A likely source region within the substorm system for the origin of most of the pressure waves is the immediate environs of the auroral electrojet. (auth)

23656 DETERMINATION OF IONOSPHERIC ELECTRON CONTENT FROM THE FARADAY ROTATION OF GEOSTATION-

ARY SATELLITE SIGNALS. Titheridge, J. E. (Univ. of Auckland, New Zealand). Planet. Space Sci.; 20: No. 3, 353-69(Mar 1972).

Calculations using a wide range of model ionospheres (with a peak at 300 km) show that the integrated electron content up to the height of the satellite could be up to four times the value deduced from Faraday rotation measurements. However, using a fixed mean field height of 400 km, the observed Faraday rotation gives the electron content up to a height h_F of 2000 km with an accuracy of ±3%. For observations at different magnetic and geographic latitudes, and geostationary satellites at different longitudes, the optimum value of h_F varies by only ±200 km. Night-time increases in the height of the ionosphere have little effect on h_F, but increase the mean field height to about 470 km. Using a fixed value of 420 km, with h_F = 2000 km, gives an accuracy of ±5 percent under most conditions. (auth)

23657 DISAPPEARANCE OF EQUATORIAL E_s ASSOCIATED WITH MAGNETIC FIELD DEPRESSIONS. Krishna Murthy, B. V.; Sen Gupta, K. (Space Science and Tech. Centre, Trivandrum, India). Planet. Space Sci.; 20: No. 3, 371-8(Mar 1972).

The phenomenon of the sudden disappearance of equatorial sporadic E at two stations, namely, Trivandrum and Kodaikanal was studied. It was established that whenever there was a sudden disappearance of E_s, there was a depression in the horizontal magnetic-field (H) range. Electron velocities during the presence and absence of sporadic E were estimated. The results show that the irregularities responsible for sporadic E are present even when the electron velocities are less than the ion thermal velocity. (auth)

23658 EQUATORIAL FARADAY ROTATION MEASUREMENTS ON THE IONOSPHERE USING A GEOSTATIONARY SATELLITE. Yeboah-Amankwah, D.; Koster, J. R. (Univ. of Ghana, Accra). Planet. Space Sci.; 20: No. 3, 395-408(Mar 1972).

Faraday rotation measurements of the equatorial ionosphere, using radiation from the ATS-C synchronous satellite, were made and analyzed. The most interesting observation concerns frequent night-time peak structures during equinoctial months. It is suggested that these peaks correspond to moving neutral plasma irregularities. The size of a typical irregularity is estimated to be about 500 km. The 10.7-cm solar flux and the sum magnetic K_p index do not appear to have a great deal of influence on the Faraday rotation; however, it was found that night-time peak structures were more likely during magnetically disturbed days than quiet days. (auth)

23659 WAVE-PARTICLE INTERACTION AROUND THE LOWER HYBRID RESONANCE. Horita, R. E. (Univ. of Victoria, British Columbia). Planet. Space Sci.; 20: No. 3, 409-21(Mar 1972).

Wave–particle interactions in the ionosphere were studied theoretically for wave frequencies around the lower hybrid resonance (LHR) frequency. An expression is derived for the growth rate of whistler-mode waves propagating in a magneto-active plasma penetrated by a tenuous beam of nonthermal particles. This expression is an extension of that derived previously by employing the electrostatic dispersion equation; the full-wave dispersion equation is used, which reduces to the electrostatic equation for large values of refractive index. It is shown that around the LHR frequency there are two regions in the propagation angle theta (the "electrostatic" and "electromagnetic" regions) where growth by the Landau instability process may occur. The maximum growth rate has an abrupt discontinuity just above the LHR frequency and increases rapidly to values several orders of magnitude higher than those below the LHR frequency. Also examined was the influence on the growth rate of the following parameters: the ratio of the temperatures perpendicular and parallel to the background magnetic field $T_\perp/T_{||}$, the streaming velocity V_s of the nonthermal electrons, and the ratio ϕ^2 of the kinetic energy in the streaming motion to the thermal energy of the streaming electrons. The theory is discussed in relation to LHR noise bands observed by the Canadian Alouette-I satellite and to other vlf signals such as auroral hiss. (auth)

23660 OBSERVATIONS OF FAST AURORAL WAVES. Boyd, J. S.; Davis, T. N.; Brown, N. B.; Hallinan, T. J.; Wallis, D. D. (Univ. of Alaska, College). Planet. Space Sci.; 20: No. 3, 437-40(Mar 1972).

Observations of fast auroral waves have been reported only infrequently. The waves are described as faint, east–west aligned, arc-like forms that travel equatorward from auroral arcs or glows in the post-midnight hours. They propagate with velocities in the range 30 to 150 km/sec and have frequencies of ~1 sec^{-1}. They have been reported to occur only when the preceding daylight hours were magnetically quiet, and only after a short-lived (1 to 2 hr) substorm. One recent fast-waves event was observed from Ester Dome Observatory near College, Alaska, the Poker Flat Rocket Launching Facility and Fort Yukon, Alaska. These sites are situated close to the 256° dipole meridian, at dp latitudes 64.6°, 64.9° and 66.6°, respectively. The authors were present at the three sites, and several photometric instruments were being operated at the time. This is the first time that such simultaneous observations have been made from separated sites, and a brief description of the event is given. (UK)

23661 MOTIONS IN THE IONOSPHERIC D AND E REGIONS. Hines, C. O. (Univ. of Toronto). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 457-71(17 Feb 1972).

Winds in the D and E regions of the Earth's upper atmosphere are analyzed into contributions derived from a general circulation, planetary waves, tidal oscillations, gravity waves, and turbulence. Some characteristics of each contribution are outlined in turn. All contributions occur naturally in a superimposed state, and the interactions between them are in many respects crucial to an understanding of the system as a whole. Many of the anticipated interactions are described, and suspected consequences to other areas of aeronomical investigation are indicated, explicitly and implicitly. Both the mapping of individual contributions, and the study of interactions and consequences, are found to provide much scope for further investigation. Some topics are highlighted that might benefit particularly from concerted observations over Europe. A critique of "ionospheric drift" measurements is included, since these measurements contain evidence of motion that must be associated with the winds of the regions to which they refer: but it is stressed that the manner of association is not yet unambiguous. (auth)

23662 SIGNIFICANCE AND INTERPRETATION OF IONOSPHERIC DRIFT MEASUREMENTS IN THE LOW-FREQUENCY RANGE. Sprenger, K. (Central Inst. for Solar-Terrestrial Physics, Berlin); Lysenko, I. A. Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 473-84(17 Feb 1972).

Ionospheric drift measurements in the low-frequency range can be shown by comparison with corresponding radar-meteor wind measurements to indicate, in general, very nearly the actual neutral air wind in the 90- to 100-km height region. From many years of such measurements at two stations in the German Democratic Republic, results have been obtained on both the prevailing and the semidiurnal (tidal) wind components, their seasonal variations, their dependence on the solar cycle, and their anomalies during certain major midwinter stratospheric warmings. (auth)

23663 RESULTS OF E-LAYER DRIFT MEASUREMENTS AT DE BILT. Vesseur, H. J. A. (Koninklijk Nederlands Meteorologisch Instituut, De Bilt, Netherlands). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 485-97(17 Feb 1972).

At the beginning of 1969 an elaborate program of E-layer drift measurements was started at De Bilt. The closely-spaced receiver method is being used in combination with an on-line analogue computer that plots the polarity-, auto-, and cross-correlation functions of the fading signals. The following results over 1969 and a part of 1970 are presented and discussed: mean hourly values of the N and E components for each month; harmonic analysis and prevailing winds, comparison between results obtained from the intersection of the correlation curves and from the time shifts for maximum cross-correlation; and comparison with the results from other stations at about the same latitude. (auth)

23664 MEASUREMENT OF IONOSPHERIC DRIFTS OVER EAST SIBERIA, U.S.S.R. Kazimirovskii, E. S.; Kokourov, V. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Irkutsk, USSR). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 499-508(17 Feb 1972).

The results of an investigation of horizontal ionospheric drifts over Irkutsk (52° N, 104° E) by the closely-spaced receiver method (D 1) are presented for 1958-59. The nature of diurnal, seasonal, and solar-cycle variations of ionospheric drift patterns are discussed. Measurement of ionospheric drifts was carried out during 1968–69 by the D 1 method (2.2 MHz) operating simultaneously at vertical and slightly oblique incidence. The results of this experiment are also discussed. (auth)

23665 RESULTS OF AN EXPERIMENTAL INVESTIGATION OF CORRELATIONS BETWEEN D-REGION NEUTRAL GAS WINDS, DENSITY CHANGES, AND SHORT-WAVE RADIO-WAVE ABSORPTION. Rose, G. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.); Widdel, H. U.; Azcarraga, A.; Sanchez, L. Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 529-45 (17 Feb 1972).

Between December 1969 and March 1970 a total of 26 Skua-II rockets were successfully launched close to local noon at Areno-

sillo, Spain, and using an ultralight chaff the winds and chaff fall rates were determined at heights between 75 and 95 km. At the same time, A_3-absorption measurements were carried out at 2.83 MHz between Aranjuez (Madrid) and Arenosillo. From the wind and fall-rate measurements, a quantity that is roughly proportional to the air mass flow was derived for each km height range. These flow vectors were obtained on different days at different height levels and correlated with the noon absorption values $L \sim \int N\nu dh$ that were taken from the short-wave propagation path between Arenosillo and Aranjuez. A significant but not very high correlation was found between the mass flow at 90 to 93 km and the absorption L, with L increasing with increased flow from the north–northeast, and at 85 km with L increasing with increased flow from the south–southwest. For the other heights between 75 and 95 km a significant correlation could not be found although there is some indication at 77 km. (auth)

23666 MESOSPHERIC TEMPERATURES AND WINDS DURING A STRATOSPHERIC WARMING. Scott, A. F. D. (University Coll., London). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 547-57(17 Feb 1972).

Increases in temperature of 60°C or more occurring in the winter stratosphere are known as stratospheric warmings. The objectives of the rocket grenade experiments described were to obtain wind and temperature profiles in the stratosphere and mesophere during a stratospheric warming. The experiments were launched from Esrange, Sweden, and from Point Barrow, Alaska, in Jan. 1969. The temperature profiles indicated that, during midwinter, a warmer stratospause is linked to a colder middle mesosphere, such as to approach summertime conditions. Amongst conclusions reached is that if the presence of a wave-like temperature structure is taken as evidence of gravity, the occurrence of a very warm stratopause would appear to inhibit gravity-wave propagation upwards into the mesosphere. The influence of planetary waves is also discussed. Two cases of anomalous stratospheric circulation preceding extreme mesospheric conditions are discussed. (UK)

23667 WINDS AND TEMPERATURES IN THE AURORAL ZONE AND THEIR RELATIONS TO GEOMAGNETIC ACTIVITY. Rees, D. (University Coll., London). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 563-75(17 Feb 1972).

Measurements of neutral wind velocity and neutral atmospheric temperature above 90 km in the auroral zone have shown distinct correlations with local and global geomagnetic activity, respectively. Individual magnetic substorms were observed to produce neutral wind speeds of over 500 m s^{-1} at 130 to 150 km. Ion–neutral particle drag is a likely accelerating mechanism with enhanced meridional electric fields and electron density. These wind disturbances can theoretically propagate to midlatitudes in the night hemisphere and produce anomalously high neutral wind speeds on a global scale especially during geomagnetic storm conditions. Such anomalously high wind speeds were observed on several occasions at midlatitude sites during disturbed conditions. Neutral temperature values in the auroral zone showed a positive correlation with geomagnetic activity with a relatively slow decay following heating. The temperature dependence upon the C9 index (which is representative of $\overline{K}_p$) is altitude-dependent, increasing from a value near to the global mean (25 K per unit C9) at 140 km to an enhanced value of 50 K per unit C9 at 165 km. Auroral-zone measurements are only possible during the period September to April inclusive; however, in this period, during quiet geomagnetic conditions and between 130 and 200 km, there is a decrease of neutral temperature of 150 ± 50 K between midlatitudes (30° N) and the auroral zone (70° N) that is significantly greater than the polewards decrease of temperature predicted from satellite drag density data. (auth)

23668 SOME STUDIES OF SPORADIC E-LAYER DRIFTS. Beynon, W. J. G.; Barrett, L. M.; Endean, R. P. J. (University Coll. of Wales, Aberystwyth). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1217, 613-22(17 Feb 1972).

The closely-spaced receiver method was employed to obtain simultaneous measurements of drift in the normal-E and the sporadic-E regions, to obtain qualitative data on height gradient of sporadic E-layer drifts, and to compare the horizontal drifts of small and large scale sporadic-E irregularities. Details are given of the experimental technique. Data were obtained for the magnitudes and directions of E and E_s drifts, monthly mean diurnal variations in E and E_s drifts, and semidiurnal and prevailing components of E and E_s drifts. The results obtained were not inconsistent with the conclusion that E_s is subject to the same tidal influences as E, but the much greater variability in the measured amplitude and phase of the E_s semidiurnal drift vector suggests that there is some additional perturbing influence operating in the case of E_s; this may be associated with the mechanisms producing the sporadic concentration of ionization. (UK)

Particle Kinetics and Trapping

23669 ABOUT THE CONNECTION BETWEEN EQUATORIAL RING CURRENT AND POLAR ELECTROJET. Grafe, A. (Zentralinstitut fuer Solar-Terrestrische Physik, Berlin). Planet. Space Sci.; 20: No. 2, 183-204(Feb 1972).

As an example the strong geomagnetic storm of May 25/26, 1967 was investigated. It can be shown that both equatorial ring current and polar electrojet disturbance fields can be the consequence of a common magnetospheric cause; however, the connection between the disturbances is not so close that they could be parts of one and the same magnetospheric–ionospheric current system. (auth)

23670 ABSENCE OF THE PLASMA SHEET AT LUNAR DISTANCE DURING GEOMAGNETICALLY QUIET TIMES. Burke, William J.; Reasoner, David L. (Rice Univ., Houston, Tex.). Planet. Space Sci.; 20: No. 3, 429-36(Mar 1972).

Plasma data from the Apollo XIV Charged Particle Lunar Environment Experiment (CPLEE) are presented to show that, contrary to previously published analyses, the plasma sheet does not extend to the lunar orbit with a thickness of 8 R_E. Two electron spectral types were observed: low-energy photoelectrons with no statistically significant medium- and high-energy fluxes and double-peaked medium- and high-energy electrons. The second type was observed either coincident with auroral substorms or at the center of the tail during quiet times. These spectra are one to several orders of magnitude less intense than plasma sheet spectra measured near 20 R_E. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 23845, 24634, and 24641.

23671 (JINR-P7-6165) IDENTIFICATION OF MULTICHARGED IONS BY INDUCED ELECTRON EMISSION. Arifov, U. A.; Mukhamadiev, E. S.; Paralis, E. S.; Pasyuk, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The mechanism of the potential electron emission induced by impact of multicharged ions on metal targets is analyzed. Experimental apparatus is described as well as the technique of the electron emission measurements in the presence of a strong magnetic field. The results of measurements of the electron emission coefficient for mixed beams are described for the purpose of their identification. The experimental data obtained are discussed. (auth)

23672 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 7, NO. 1, 1972. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 68p.

This listing includes 267 references on such topics as: bombardment or irradiation, collision phenomena, implantation, sorption and desorption, and spectroscopy. (L.M.T.)

23673 DEDUCTION OF HEAVY-ION X-RAY PRODUCTION CROSS SECTIONS FROM THICK-TARGET YIELDS. Taulbjerg, Knud (Univ. of Aarhus, Denmark); Sigmund, Peter. Phys. Rev., A; 5: No. 3, 1285-9(Mar 1972).

The conventional formula determining x-ray production cross sections from thick-target yields has to be corrected for the effects of energy-loss straggling, x rays from recoil atoms, and nonstraight ion trajectories when heavy (keV and low MeV) ions are used as projectiles. The first two corrections are evaluated for the case where the last is small (negligible absorption). Carbon K x-ray cross sections are deduced from published yield data. Large corrections, up to one order of magnitude, are found. (auth)

23674 Si Kα X-RAY SPECTRUM PRODUCED BY 30-MeV OXYGEN BOMBARDMENT. McCrary, D. G.; Richard, Patrick (Univ. of Texas, Austin). Phys. Rev., A; 5: No. 3, 1249-52(Mar 1972).

Kα x rays of Si were produced by 30-MeV oxygen bombardment of a Si wafer. Nine Kα lines are observed with an energy resolution of 2.5 eV at energies of 1739.78 ($K\alpha_{1,2}$), 1750.8 ± 0.5 ($K\alpha_3$), 1753.1 ± 0.6 ($K\alpha_4$), 1762.6 ± 0.5 ($K\alpha_5$), 1766.4 ± 0.6 ($K\alpha_6$), 1775.3 ± 0.6, 1778.8 ± 0.5, 1794.2 ± 0.6, and 1809.7 ± 0.8 eV. The intensity pattern is very nearly symmetric and the envelope approximately Gaussian. The energies of these lines are found to agree with Hartree-Fock-Slater calculated energies for Kα transitions from Si atoms with initial configurations $(1s)^{-1}(2p)^{-n}$ for n = 0, 1, 2, 3, 4, and 5. (auth)

23675 COLLISIONS IN A PARALLEL ATOMIC BEAM. Zankel, K. (CERN, Geneva). J. Phys., B (London); 5: No. 1, 74-9(Jan 1972).

A calculation is given for the collision frequency and the angular distribution of particles scattered from a well-collimated atomic beam. It is assumed that their total number is small. Results are plotted for the flow from a supersonic nozzle with the Mach number varying from 0 to 8. (auth)

23676 MULTIPLE SCATTERING AND ENERGY LOSSES OF HELIUM IONS IN ALUMINUM BELOW 300 keV. Bednyakov, A. A.; Ignatov, V. G.; Tulinov, A. F.; Shustikov, Yu. N. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 402-10(Jul-Aug 1971). (In Russian).

The angular distribution $N_E(\theta)$ of ^4He ions was measured during multiple scattering in Al foils from 25 to 105 $\mu g/cm^2$ thick. In contrast to hydrogen ions, the effect of screening by electrons of the nuclear fields of the scattered He ions is significantly noticeable in the overall scattering result at energies as low as 300 keV. Specific energy losses were measured for ^4He ions in this energy range. (tr-auth)

23677 TRIPLET EXCITATION OF WATER AND METHANOL BY LOW-ENERGY ELECTRON-IMPACT SPECTROSCOPY. Knoop, F. W. E. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam); Brongersma, H. H.; Oosterhoff, L. J. Chem. Phys. Lett.; 13: No. 1, 20-3(1 Feb 1972).

Electronic excitation by low-energy electron impact was studied for water and for methanol. In the case of water a triplet excitation process was observed at 7.2 eV energy loss, and for methanol probably a similar process was found at 6.5 eV. The weak and broad absorption peaking at 4.4 to 4.6 eV in the water spectra seems to have an analog in methanol observed at an energy loss of ~4.4 eV. (auth)

23678 SURFACE IONIZATION TYPE ION SOURCE OF Ba^+ IONS FOR USE IN COLLISION EXPERIMENTS. Feeney, R. K.; Bacon, F. M.; Elford, M. T.; Hooper, J. W. (Georgia Inst. of Tech., Atlanta). Rev. Sci. Instrum.; 43: No. 3, 549-50(Mar 1972).

A surface-ionization-type ion source, which produces a Ba^+ ion beam of known chemical purity and excitation state, was developed specifically for use in collision experiments. Barium vapor is surface-ionized on a rhenium filament that is heated to approximately 1800°C by the passage of a direct current. The water-cooled source provides ion currents of about 10 μA and can be operated without differential pumping in a vacuum environment of (3 to 4) × 10^{-9} torr. (auth)

Atomic and Molecular Properties

Refer also to abstracts 23595, 23728, 23756, 23776, and 24697-24698.

23679 EXPECTATION VALUES OF $(r^n)_{4f}$ FOR RARE-EARTH IONS. Wakim, F. G.; Synek, M.; Grossgut, P.; DaMommio, A. (Texas Christian Univ., Fort Worth. Univ. of Texas, Austin). Phys. Rev., A; 5: No. 3, 1121-4(Mar 1972).

The average values of the powers of r for the 4f orbital, $(r^n)_{4f}$, were calculated using accurate analytical self-consistent-field wave functions. The results were compared with experimental and other theoretical values. (auth)

23680 PHOTOIONIZATION OF LITHIUM, SODIUM, AND POTASSIUM AND PHOTODETACHMENT OF THE NEGATIVE HYDROGEN ION. Smith, Richard Lee. Baton Rouge, La.; Louisiana State Univ. (1971). 76p. University Microfilms Order No. 72-3526.

Thesis.

In Part I a pseudopotential formalism is used to calculate the cross section for photoionization of sodium, lithium, and potassium for ejected-electron energies from threshold to about 15 eV. Both the dipole length and dipole velocity matrix forms are computed. For sodium the dipole-length results are in good agreement with experiment away from the lowest threshold. The dipole velocity results for sodium, on the other hand, severely underestimate the cross section except very near threshold. For lithium the dipole-length and velocity results are less than the experimental results but compare favorably with other theoretical results. For potassium the cross section exhibits the general shape of experimental curves. In Part II the variational method proposed by F. E. Harris and extended by R. K. Nesbet is employed to obtain wave functions for the singlet p-wave continuum functions of the negative hydrogen ion, using a 1s-2s-2p close-coupling approach. The bound-free absorption coefficient is calculated using length, velocity, and acceleration forms of the dipole matrix element. The results of these calculations are presented. Particular attention is given to the energy region near 0.751 Ry where the ^1P shape resonance exists. Comparison of the results from the length, velocity, and acceleration operator methods indicates that the wave functions obtained by this variational method are sufficiently accurate for calculating the photodetachment of H^-. (Diss. Abstr. Int., B)

23681 ATOMIC VACANCY DISTRIBUTIONS PRODUCED BY INNER-SHELL IONIZATION. Rao, P. Venugopala; Chen, Mau Hsiung; Crasemann, Bernd (Univ. of Oregon, Eugene). Phys. Rev., A; 5: No. 3, 997-1012(Mar 1972).

Average L- and M-shell-vacancy distributions produced in the de-excitation of atoms that have been singly ionized in the K shell or one of the L subshells are derived from a comprehensive set of available experimental and theoretical data on radiative- and Auger-transition rates. The data are supplemented by new calculations in j-j coupling from nonrelativistic screened hydrogenic wave functions of the following radiationless transitions rates: K-LL, K-LM, and K-LN for selected elements with 20 ≤ Z ≤ 81, and L_1-MM, L_1-MX, and L_1-XY for 26 ≤ Z ≤ 93. Experimental and theoretical data on Auger- and radiative-transition probabil-

ities are critically compared. Auger-electron intensity ratios and $K\alpha_2/K\alpha_1$ and $K\beta/K\alpha$ x-ray intensity ratios from a best fit to experimental data are tabulated for even atomic numbers from 20 to 94. The probability, per initial K vacancy, of vacancy production in each L_i subshell is derived from experimental data and tabulated for $20 \leq Z \leq 94$; components due to Auger and x-ray transitions are listed separately. These probabilities agree well with purely theoretical vacancy distributions also derived here. The probability of M-shell-vacancy production in the decay of K and L_i vacancies is derived from theory and tabulated for selected atoms with $16 \leq Z \leq 93$. (auth)

23682 LASER-INDUCED QUENCHING OF METASTABLE DEUTERIUM ATOMS. SINGLY STIMULATED TWO-PHOTON EMISSION AND ANTI-STOKES RAMAN SCATTERING. Braeunlich, P.; Hall, R.; Lambropoulos, P. (Bendix Research Labs., Southfield, Mich.). Phys. Rev., A; 5: No. 3, 1013-25(Mar 1972).

An experimental arrangement for the measurement of singly stimulated two-photon emission and anti-Stokes Raman scattering from metastable deuterium atoms is described. The atoms, produced by charge exchange between cesium vapor and 5-keV deuterons, are subjected to intense light pulses from a Nd-glass laser. The generated photons are detected at the exit slit of a vacuum-uv spectrometer. The results are compared with theoretical calculations by Zernik. (auth)

23683 LIFETIME OF THE c $^3\Pi_u$ METASTABLE STATE OF H_2, D_2, AND HD. Johnson, Charles E. (Univ. of California, Berkeley). Phys. Rev., A; 5: No. 3, 1026-30(Mar 1972).

The lifetime of the v = 0 c $^3\Pi_u$ metastable state of H_2, D_2, and HD was measured using the time-of-flight technique. The velocity distribution of a thermal beam of metastable molecules is sampled and detected at two positions, 1.9 and 6.7 m from the pulsed electron gun used to excite the ground-state molecules effusing from a source slit. A comparison of the number of metastables within specific velocity intervals at the two detectors determines the number that decay in flight and yields an experimental plot of the number that decay versus time of flight. The lifetime τ is then obtained from the slope ($= -1/\tau$) of a straight line least-squares fitted to the decay plot. The result, $\tau = 1.02 \pm 0.05$ ms, is the same for both para- and ortho-H_2, as well as for D_2 and HD. Since all three isotopic combinations have the same measured lifetime, and since the lifetime for a forbidden predissociation through spin–orbit mixing with the $^3\Sigma_u^+$ state would be expected to depend upon details of the fine structure, this value is the radiative lifetime for a combination of magnetic-dipole electric-quadrupole decay of the v = 0 ^3H_u state to the repulsive $^3\Sigma_u^+$ state. (auth)

23684 ATOMIC M-SHELL COSTER–KRONIG, AUGER, AND RADIATIVE RATES, AND FLUORESCENCE YIELDS FOR Ca THROUGH Th. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 5: No. 3, 1043-7(Mar 1972).

Calculated Auger, Coster–Kronig, super Coster–Kronig, and radiative transition rates are used to compute atomic M–shell Auger, Coster–Kronig, and fluorescence yields. Comparison is made with five fluorescence-field measurements, with full width at half-maximum measurements of L–M x rays, and with Bhalla's relativistic radiative-yield calculations. (auth)

23685 INFLUENCE OF FINITE-DISTANCE BOUNDARY CONDITIONS ON QUANTIFICATION OF THE HYDROGEN ATOM. Janssens, P.; Van Dooren, R.; Delchambre, M. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 57: 545-58(1971). (In French).

The quantum states of a bounded particle in a spherical symmetric potential are studied under the influence of different nonclassical boundary conditions, such as annulling the wave function upon a given sphere. The cases of Schrödinger, Klein–Gordon and Dirac equations are examined. (auth)

23686 RECENT MEASUREMENTS OF THE COSTER–KRONIG PROBABILITY f_{23} IN THE REGION $Z \geq 90$. Campbell, J. L. (Univ. of Guelph, Ont.). J. Phys., B (London); 5: No. 2, L40-4 (Feb 1972).

The method adopted hitherto for measurement of the L_2-subshell fluoresence and Coster–Kronig yields ω_2, f_{23}, in the region $Z \geq 90$ is shown to be extremely sensitive to the value assumed for the intensity ratio L_α/L_β of x rays arising from L_3 vacancies; a recent result for f_{23} is altered by a factor of 3 when the Hartree–Slater value of this ratio is used. More direct methods of studying L_2-subshell yields are proposed. Data are given for U, Pu, and Cm isotopes. (auth)

23687 AB INITIO CALCULATION OF CORE RELAXATION AND SCREENING EFFECTS ON $|\psi(0)|^2$ FOR Sm AND Eu. Wilson, M. (London Univ.). J. Phys., B (London); 5: No. 2, 218-28 (Feb 1972).

Hartree–Fock calculations of the s-electron density at the nucleus were made for a selection of electron configurations in Sm I to IV and Eu I to IV chosen for their interest in interpreting observed isotope and isomer shifts. Theoretical screening ratios and core relaxation effects are discussed and compared with those derived by empirical means. (auth)

23688 IMPROVED LOWER BOUNDS TO ENERGY LEVELS. Cohen, M.; Feldmann, T.; McEachran, R. P. (Hebrew Univ., Jerusalem). J. Phys., B (London); 5: No. 2, 193-8(Feb 1972).

Improved lower bounds to the energy levels of the 1s ns ^1S states of helium through n = 6 were calculated with analytical orbital wave functions using an extension of the methods of Cohen and Feldmann (Can. J. Phys. 47: 1877(1969) and 48: 1681(1970)). For the excited states, these bounds are all within 1.25% of the observed levels, and the error reduces to 0.15% for the highest levels. These results confirm the reliability of the frozen core wave functions for excited states. (auth)

23689 EXCHANGE INTERACTION BETWEEN IONIC AND COVALENT STATES OF TWO ATOMS AT LARGE DISTANCES. Janev, R. K. (Inst. of Physics, Belgrade. Boris Kidric Inst. of Nuclear Sciences, Belgrade); Salin, A. J. Phys., B (London); 5: No. 2, 177-83(Feb 1972).

The exchange interaction between the ionic and the covalent states in the system of two atoms is considered at large internuclear distances. This interaction determines the nonadiabatic transition probabilities in systems such as $A^* + B$ or $A^+ + B^-$. An asymptotically exact expression for this interaction is obtained, accounting for the long-range (polarization) interaction in the system. (auth)

23690 FINE STRUCTURE MEASUREMENT IN He^+, n = 4. II. INTERVALS S–D AND LAMB SHIFT $P_{\frac{1}{2}}-D_{\frac{5}{2}}$. Beyer, H.-J.; Kleinpoppen, H. (Univ. of Stirling, Scotland). J. Phys., B (London); 5: No. 1, L12-15(Jan 1972).

Electric-field-induced anticrossing signals were used to measure the fine-structure splittings S–D of n = 4 in $(^4He)^+$. Extrapolation of the crossing position to zero electric field was carried out. The results were (20145.3 ± 7.8) MHz for the interval $4^2S_{\frac{1}{2}}-4^2D_{\frac{3}{2}}$ and (27455.4 ± 7.4) MHz for the interval $4^2S_{\frac{1}{2}}-4^2D_{\frac{5}{2}}$, in agreement with Erickson's theoretical values of (20142.85 ± 1.36) MHz and (27458.60 ± 1.36) MHz, respectively. The splitting $4^2D_{\frac{3}{2}}-4^2D_{\frac{5}{2}}$ derived from these intervals was (7310.1 ± 15.2) MHz compared with (7315.75 ± 0.02) MHz from the theory. Combining $4^2S_{\frac{1}{2}}-4^2D_{\frac{3}{2}}$ with $4^2S_{\frac{1}{2}}-4^2P_{\frac{1}{2}}$, measured by Jacobs et al, provides a value for the Lamb shift $4^2P_{\frac{1}{2}}-4^2D_{\frac{3}{2}}$ of Σ = (34.4 ± 9.0) MHz compared with the theoretical value of (37.19 ± 1.36) MHz. (auth)

23691 NUMBER OF VIBRATIONAL LEVELS OF THE MOLECULAR HYDROGEN ION. Matvienko, A. V. (Inst. for Theoretical Physics, Kiev); Ponomarev, L. I. J. Phys., B (London); 5: No. 1, 27-8(Jan 1972).

The variable phase method was used for the calculation of some properties of the H_2^+ molecular hydrogen ion. It was found that in the lowest ungerade static potential of the H_2^+ molecule there exist 2 bound states. The scattering lengths for the lowest gerade and ungerade potentials are $a_g = -30$ au, $a_u = 7.6 \times 10^2$ au. There is no appreciable change in these values due to the adiabatic corrections. (auth)

23692 VIBRATIONAL AND ROTATIONAL ANALYSIS OF EIGHT SIMPLE MODELS OF THE HYDROGEN MOLECULE IN THE GROUND STATE. Hayes, Stuart Fleming. Albuquerque, N. Mex.; Univ. of New Mexico (1971). 350p. University Microfilms Order No. 72-3993.

Thesis.

The influence of polarization, enhancement of charge between the nuclei, and variation of the screening parameter on the ΔG curve for H_2 was investigated. Also investigated was the correlation between these factors and the vibrational and rotational spectroscopic constants, particularly B_v. The Heitler–London combination of atomic orbitals (referred to as ϕ_1) was used in every wave function investigated. The atomic orbital 2pz was used in ϕ_2 (polarization) and ϕ_3 (charge enhancement). In each of these functions the screening parameter α was either set equal to 1 or was varied. The method of linear variation functions (ϕ_1, ϕ_2, ϕ_3 being the functions) was used to solve for the electronic energy in the Born–Oppenheimer approximation. The sum of the electronic energy and the energy of repulsion of the nuclei served as a model for examination of vibration and rotation of the nuclei. Eight models were studied. The integrals were formulated in closed form after the fashion of Rosen and of Hirschfelder and Linnett. Rotationless vibrational levels and B_v values were obtained for each model by applying the Cooley numerical integration procedure to each energy function. The Dunham formulation or a fit to the levels was applied to obtain various spectroscopic constants. Rotational levels were obtained by treating the centrifugal reaction term as a perturbation of the pure vibration. The values of R_e

(classical internuclear equilibrium separation) for $\alpha = 1$ were all too large by about 0.25 au. For α variable they were close to the experimental value, but the lowest energy minimum was 0.7 eV above experiment. Beyond R = 10 au in cases that included polarization nearly all the energy was of the R^{-6} form. Examination of numerical values of the square of the wave function supported the expectation that ϕ_2 would be associated with polarization for large values of R, that inclusion of ϕ_3 would lead to an increase of charge between the nuclei, and that variation of α would affect the charge distribution significantly. The ΔG and B_v curves for the four models for which $\alpha = 1$ had negative curvature at small v, but the curves for the four models for which α was varied exhibited a positive curvature instead. The effect of polarization upon the curves was not obvious until the Cooley computations were carried out for increased reduced masses of the molecule (such as 81 times the normal reduced mass of H_2). For these, the ΔG and B_v curves exhibited a positive curvature near the dissociation limit when polarization was included but not otherwise. (Diss. Abstr. Int., B)

23693 PRECISE CALCULATIONS OF ATOMIC ELECTRON BINDING ENERGIES IN FERMIUM. Fricke, B.; Desclaux, J. P.; Waber, J. T. (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett.; 28: No. 12, 714-16(20 Mar 1972).

The comparison between the experimental binding energies for the K, L, and M electrons for fermium and the results of our Dirac–Fock calculation, taking into account all tractable corrections, leads to agreement within about 20 eV. This shows that the present method of calculation is an adequate description of this problem and that nonlinear electrodynamical effects will not be present in nature or will be smaller than 1% compared to the values recently proposed. It is found that the energies of electronic transitions can now be used to estimate the nuclear radius. (auth)

23694 EXPERIMENTAL INNER-ELECTRON BINDING ENERGIES IN $_{100}$Fm AND LIMITS ON ELECTRODYNAMIC NONLINEARITIES. Freedman, M. S. (Argonne National Lab., Ill.); Porter, F. T.; Mann, Joseph B. Phys. Rev. Lett.; 28: No. 12, 711-13 (20 Mar 1972).

An earlier experimental value for the 1s binding energy in Fm (141.967 ± 0.013 keV) agrees with a precision relativistic Hartree–Fock calculation using linear electrodynamics to 2 ± 35 eV. This result is compared with a recent approximate calculation of the reduction (3.3 keV) in this binding energy when Born–Infeld nonlinear electrodynamics is used, and it indicates that such nonlinearities are limited to the order of 1% of Born–Infeld theory. (auth)

23695 DISCUSSION OF THE He–He INTERACTION ENERGY IN THE AVERAGE ENERGY APPROXIMATION. Kreek, H.; meath, William J. (Univ. of Western Ontario, London, Can.). Mol. Phys.; 22: No. 5, 915-30(1971).

Using the Unsöld average-energy method, a double perturbation theory expression for the interaction energy through second order is obtained, which includes intra-atomic correction terms arising from the use of trial wave functions to represent the noninteracting molecules. These formal expressions are applied to the ground-state He–He interaction, and results for the interaction, and results for the interaction energy are obtained that compare favourably with recent semi-empirical and ab initio calculations. The Unsöld calculations are used to investigate approximations that have been introduced into the average-energy calculation by other workers, and as a model for discussing the relative importance of second-order charge overlap and exchange effects and the convergence of the multipole treatment of the interaction energy for this typical nonbonded interaction. The results illustrate the importance of knowing as many terms as possible in the R^{-1} expansion of the energy. Finally a portion of this work required the recalculation of the He–He repulsive energy obtained by using the Eckart wave function to represent the helium atom. The resultant energy is approximately 25% lower than that previously obtained using this wave function for most values of R. (auth)

23696 L FLUORESCENT X-RAY RELATIVE-INTENSITY MEASUREMENTS. McCrary, J. H.; Singman, L. V.; Ziegler, L. H.; (and others) (EG and G, Inc., Las Vegas, Nev.). Phys. Rev., A; 5: No. 4, 1587-91(Apr 1972).

Measured values of the relative intensities of several L fluorescent x rays are reported for 13 elements ranging from cerium through plutonium. A solid-state Si(Li) spectrometer and a Bragg-diffraction spectrometer were used to analyze the x-ray excited fluorescence from thin samples. Corrections were made to the measured relative intensities for sample absorption, air absorption, and spectrometer efficiency. The accuracy of the measurements varies from ±5 to ±15%. The results are compared with those from the Scofield calculations. (auth)

23697 ACCURATE NUMERICAL HARTREE–FOCK SELF-CONSISTENT-FIELD WAVE FUNCTIONS FOR Ce^{3+}, La^{2+}, Yb^{3+}, Tm^{2+}, AND Yb^{2+}. Saxena, K. M. S. (Univ. of Alberta, Edmonton). Phys. Rev., A; 5: No. 4, 1619-20(Apr 1972).

Accurate numerical Hartree–Fock (HF) self-consistent-field (SCF) wave functions were obtained for Ce^{3+} $(4f^1)$ ^2F, La^{2+} $(4f^1)$ ^2F, Yb^{3+} $(4f^{13})^2F$, Tm^{2+} $(4f^{13})^2F$, and Yb^{2+} $(4f^{14})$ ^1S rare-earth ions. In each case, the virial theorem is satisfied to at least six digits and the P_{nl} radial functions are self-consistent and without "tail oscillations" to three decimal places. Several HF parameters are also evaluated with these wave functions. (auth)

23698 VIBRATIONAL CORRECTION TO CALCULATION OF THE COMPTON PROFILE OF H_2. Ulsh, R. C.; Bonham, R. A.; Bartell, L. S. (Indiana Univ., Bloomington). Chem. Phys. Lett.; 13: No. 1, 6-8(1 Feb 1972).

The Compton profile of H_2 is calculated, with and without a vibrational effect included, using a Wang wave function. It is found that the anharmonicity of the H_2 potential-energy curve causes a 1% increase in J(q) at low electron momentum. (auth)

23699 STRUCTURE OF THE SPECTRUM OF NEUTRAL TERBIUM, Tb I. PART VI. THE SEXTET SYSTEM OF $4f^8(^7F)5d6s^2$. Klinkenberg, P. F. A. (Univ. of Amsterdam). Physica; 57: No. 4, 594-615(15 Feb 1972).

The analysis of the A system in the Tb I spectrum is extended to include 5394 observed spectral lines, classified between 46 even and 451 odd levels. Two of the new even levels are attributed to the configuration $4f^85d^26s$, and one of them amplifies the fundamental ^8H term of $4f^85d6s^2$. The remaining seven are identified as sextet levels in the subconfiguration $4f^8(^7F)5d6s^2$. The outlines of the sextet system herewith become clear although ^6D and ^6P are still undetected and none of the other terms is complete. In the odd group it is possible to recognize the lowest odd subconfiguration in system A, viz. $4f^8(^7F)6s^26p$. Peculiar Zeeman patterns are discussed in connection with hyperfine structure. The observations are consistent only with an inverted hyperfine splitting of the level $4f^8(^7F)5d6s^2{}^8F_{\frac{1}{2}}$. (auth)

23700 ELECTRONIC STRUCTURE OF SUPERHEAVY ATOMS. Zel'dovich, Ya. B.; Popov, V. S. Usp. Fiz. Nauk; 105: No. 3, 403-40(Nov 1971). (In Russian).

An exposition is given of the electronic structure of atoms with a nuclear charge $Z > Z_c$ where $Z_c \approx 170$, a critical value for which the energy of the ground state of the $1S_{\frac{1}{2}}$ electron approaches the boundary of the lower continuum for solutions of the Dirac equation ($\epsilon = -m_e c^2$). The dependence of Z_c on the nuclear radius and on the character of the distribution of the electronic charge within the nucleus is discussed, as well as the form of the wave function where Z approaches Z_c. Because of the Coulomb barrier, the electron state remains localized for $Z \rightarrow Z_c$, notwithstanding the fact that its energy approaches that of the continuum. An examination of the vacuum polarization in a strong Coulomb field shows that a bare nucleus with a supercritical charge $Z > Z_c$ produces two positrons. There also arises a supplementary plane of charge in the vacuum, cumulatively carrying two units of negative charge. The distribution of this plane is localized in a region $r \sim \hbar m_e c$ near the nucleus. The possible experimental observation of quasi-statistical positron production during the collision of two bare (i.e., stripped of electrons) uranium nuclei is discussed. A short review on the position of the levels as a function of the depth of the potential wells in other relativistic equations (Klein–Gordon, Proca, etc.) is given. (2 tables, 14 figures, 86 references) (tr-auth)

23701 EXPERIMENTAL EVIDENCE FOR THE EXISTENCE OF TRI-ATOMIC HYDROGEN MOLECULES. Nagasaki, T.; Doi, H.; Wada, K.; Higashi, K.; Fukuzawa, F. (Kyoto Univ.). Phys. Lett.; 38A: No. 6, 381-2(13 Mar 1972).

By the successive charge-exchange technique with 180-keV D_3^+ ion ($D_3^+ \rightarrow D_3^0 \rightarrow D_3^+$), the existence of D_3^0 is confirmed. The estimated lifetime of D_3^0 is more than 10^{-7} sec. (auth)

23702 HYPERFINE STRUCTURE OF THE MOLECULAR ION H_2^+. Kalaghan, P. M.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Lett.; 38A: No. 7, 485-6(27 Mar 1972).

Precise calculations are reported of the ρ-type doubling constant of H_2^+. The results differ from the values derived from measurements of transition frequencies by less than 0.1% or 30 kHz. Taken in conjunction with measurements of the transition frequencies, similar calculations for HD^+ can yield a precise value of the quadrupole moment of the deuteron. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 24680.

23703 $\alpha^2 \ln \alpha^{-1}$ CORRECTION TO THE FINE-STRUCTURE OF POSITRONIUM. Roemer, David K. New York; New York Univ. (1971). 48p. University Microfilms Order No. 72-3119.

Thesis.

The $m\alpha^6 \ln \alpha^{-1}$ contribution to the triplet-singlet splitting of the ground state of positronium from the exchange of one and two photons is calculated. No contribution was found from the exchange of one transverse photon. The two transverse-quantum ladder diagram and the two quantum crossed diagram gave the correction $\Delta\nu = (3/8)\, m\alpha^6 \ln \alpha^{-1}$. The Coulomb recoil effect was found to be $\Delta\nu = (1/48)\, m\alpha^6 \ln \alpha^{-1}$. The total result is $\Delta\nu = (19/48)\, m\alpha^6 \ln \alpha^{-1} = 36$ MHz. This raises the theoretical value of the fine-structure to $\Delta\nu$(theory) = $(2.03415)10^5$ MHz, which is one standard deviation above the experimental value: $\Delta\nu$(experimental) = $(2.03403 \pm .00012)10^5$ MHz. (Diss. Abstr. Int., B)

23704 TRANSFER RATE OF NEGATIVE PIONS FROM GASEOUS HYDROGEN TO ARGON. Picard, J. (CERN, Geneva); Placci, A.; Polacco, E.; (and others). Lett. Nuovo Cim.; 2: No. 18, 957-9(30 Oct 1971).

Measurement of the transfer rate of pions stopped in gaseous hydrogen at 1 absolute atmosphere to Ar according to the reaction $(\pi^- p)^* + Ar \rightarrow (\pi Ar) + p$ is reported. The transfer rate was found to be $(4 \pm 1.8) \times 10^9\ s^{-1}$. From this value, a value of 6×10^{-18} cm^2 was obtained for the cross section for transfer of a pion to an argon atom. It is concluded that the transfer occurs at an interatomic distance of the order of the electronic Bohr radius and that the pion is transferred from a highly excited level of the $(\pi p)^*$ system. (A.G.W.)

Collision Phenomena

Refer also to abstracts 23542, 23757, and 24473.

23705 (COO-2101-29) PHYSICAL INTERPRETATION OF GLORY UNDULATIONS IN SCATTERING CROSS SECTIONS. Greene, E. F.; Mason, E. A. (Brown Univ., Providence, R. I.). [1971]. 18p. Dep. NTIS.

The physical interpretation of the spacing of glory undulations as a function of energy is approached through the interpretation of the coefficients in a semiclassical expansion in the relative kinetic energy of the form $(a_1 - A_1K^{-1} + A_2K^{-2} + \ldots)$. The coefficient a_1 measures the area of the intermolecular potential well along the glory trajectory, whereas A_1 and A_2 give measures of the square and cube of the well, respectively. Examples are given for square-well and Lennard-Jones (n,6) potentials. Measured values of the spacings of the glory oscillations for a system do not give as specific information on the potential as has sometimes been conjectured, but the information obtainable is quite definite and can be used to put constraints on the form of the potential for that system. (auth)

23706 EXPERIMENTAL DETERMINATION OF ELECTRON-TRANSFER CROSS SECTIONS FOR FLUORINE IONS IN NITROGEN AT ENERGIES FROM 4 TO 54 MeV. Macdonald, J. R.; Ferguson, S. M.; Chiao, T.; Ellsworth, L. D.; Savoy, S. A. (Kansas State Univ., Manhattan). Phys. Rev., A; 5: No. 3, 1188-94 (Mar 1972).

Electron-capture and -loss cross sections were measured for fluorine ions passing through nitrogen gas in the energy range from 5 to 54 MeV. Cross sections for multiple electron transfer in a single collision were obtained in the analysis with quadruple capture and triple loss determined in some cases. The velocity dependence of the capture cross sections is discussed, and capture by the bare fluorine nucleus is in good agreement with theory. The ratio of the cross sections for double to single capture are discussed in terms of a geometry-independent component of the electron-capture process. The cross sections for electron loss are presented and a comparison is made between the velocity dependence observed and an elementary theoretical mode. (auth)

23707 EXCITATION OF THE n = 4 LEVEL OF He^+ BY ELECTRON IMPACT ON He. Anderson, R. J.; Hughes, R. H. (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 5: No. 3, 1194-7(Mar 1972).

The simultaneous ionization and excitation of helium to the n = 4 level of He^+ by 200-eV electron impact on helium was studied by time-resolved spectroscopy of the λ = 4686-Å (n = 4 → 3) line of He^+. The study revealed that the excitation process is complex. It appears that only about 70% of the excitation of the λ = 4686-Å line can be accounted for by direct simultaneous ionization and excitation of the helium atom to the n = 4 level of He^+ under single electron–atom collision conditions. (auth)

23708 NEW CLASSICAL MODEL FOR PROTON-IMPACT IONIZATION OF ATOMS. Roy, B. N.; Tripathi, D. N.; Rai, D. K. (Banaras Hindu Univ., India). Phys. Rev., A; 5: No. 3, 1252-5 (Mar 1972).

A new model for ionizing collisions between slow protons and atoms is proposed. K-shell ionization cross sections of oxygen atoms are calculated and compared with available experimental data and with the results obtained by Gryzinski's formula. The proposed modification gives very good results for the cross section. (auth)

23709 CHARGE TRANSFER AND IONIZATION IN COLLISIONS BETWEEN ATOMIC IONS AND RARE-GAS ATOMS FOR PRIMARY-ION ENERGIES BELOW 100 eV. Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., A; 5: No. 3, 1256-68(Mar 1972).

Cross sections for the production of Kr^+, Kr^{++}, Xe^+, and Xe^{++} in collisions of H^+, He^+, and Ne^+ with Kr and Xe were measured for primary-ion kinetic energies E between 0.5 and 100 eV. These cross sections rise rather sharply as E is increased, reach a maximum, and then decrease rather slowly. Maximum values of the cross sections range from 0.1 to 40 $Å^2$. Production of the doubly charged ions must correspond to the production of a free electron; these ionization processes have apparent threshold energies 0 to 4 eV above the true threshold energies. Collisions of H^+ with Kr and Xe do not produce doubly charged positive ions. The cross sections for reactions that release a free electron are not adequately represented by any of the theoretical expressions with which the experimental data were compared. Cross sections for the production of singly charged positive ions are larger for the more complex target atoms and lighter primary ions; these cross sections are well represented by the charge-transfer theory of Rapp and Francis when the experimental cross sections are large, but not otherwise. Rapp and Francis's formulas are not applicable to charge-transfer reactions having small cross sections. The present experimental data agree fairly well with previous experimental results. (auth)

23710 ATOMIC SYSTEMS WITH A CLOSED CORE PLUS TWO ELECTRONS. Fung, Albert Ai-chun. Baton Rouge, La.; Louisiana State Univ. (1971). 106p. University Microfilms Order No. 72-3487.

Thesis.

Part I consists of the formulation of a simplified method of superposition of configurations of Weiss for the calculation of detachment potentials for systems with two electrons outside a closed core. The simplification does not impair the accuracy of the results. For the detachment potentials of Be, Li^-, and Na^- all agree with Weiss to within 0.01 eV. It has the further advantage of the ease of constructing projection operators used in determining autoionization states for e^-–alkali atom systems, similar to the method proposed by Hahn, O'Malley, and Spruch. For Li three autoionization states have been found below the $1s^23s$ level and four below the $1s^23p$ level. Only one autoionization state is found for Na. Part II deals with an optical-potential method for the calculation of the elastic scattering of positrons from hydrogen atoms. The single-particle states of the electron are chosen to be the hydrogenic solutions while the positron states are obtained by using a model polarization potential. Various models are investigated and a choice is made which effectively maximizes the calculated phase shifts through second-order in the perturbation expansion of the optical potential. Phase shifts thus obtained yield approximately 67 to 80% of the difference between the static Hartree results and the variational results of Schwartz. (Diss. Abstr. Int., B)

23711 COUPLED-STATE CALCULATIONS OF H^+–H SCATTERING. Rapp, Donald (Univ. of Texas, Dallas); Dinwiddie, David; Storm, David; Sharp, Terry E. Phys. Rev., A; 5: No. 3, 1290-7(Mar 1972).

A numerical calculation was performed for proton–hydrogen–atom scattering using 1s, 2s, $2p_0$, and $2p_1$ hydrogenic states in a two-center traveling-wave expansion in the impact-parameter method. Discrepancies with past work are pointed out and discussed. Cross sections for direct and exchange scattering into 1s, 2s, and 2p states, as well as the polarization, are presented for ion energies from 500 eV to 400 keV. Results are compared with other calculations using different expansion functions, both hydrogenic and "pseudostate." (auth)

23712 ELECTRONIC TRANSITIONS IN SLOW COLLISIONS OF ATOMS AND MOLECULES. IV. MULTISTATE EIKONAL APPROXIMATION FOR QUASI-ADIABATIC TRANSITIONS. Chen, Joseph C. Y. (Univ. of California, San Diego, La Jolla);

Joachain, Charles J.; Watson, Kenneth M. Contract AT(04-3)-34. Phys. Rev., A; 5: No. 3, 1268-85(Mar 1972).

The coupled equations of the adiabatic-state expansion method for quasi-adiabatic transitions in atomic collisions are reduced in the eikonal approximations to a form that allows straightforward computation. The multistate eikonal approximation is then applied to the $He^+(1s) + H(1s) \rightarrow He^+(1s) + H(2p)$ excitation process. The partial and total 2p-excitation cross sections as well as the polarization of the light emitted by the excited H atoms are calculated. The results compare well with recent experimental measurements. The importance of final-state coupling is dramatically illustrated by the above 2p-excitation process. The qualitative features of the nonadiabatic effects are also investigated in the eikonal Born approximation as functions of the position and distance of closest approach of the two adiabatic states. (auth)

23713 PRODUCTION OF K X RAYS BY 160-MeV PROTONS. Jarvis, O. N. (Atomic Energy Research Establishment, Harwell, Eng.); Whitehead, C.; Shah, M. Phys. Rev., A; 5: No. 3, 1198-1207(Mar 1972).

K-shell ionization cross sections were measured for elements between Z = 26 and Z = 92 using 160-MeV protons as incident projectiles. The results are compared with two theoretical models, the plane-wave-Born-approximation calculations of Khandelwal, Choi, and Merzbacher and the binary-encounter model of Garcia. The results are in qualitative agreement with both these nonrelativistic models. The necessity for a relativistic theory is emphasized by comparison with recent high-energy-electron measurements. (auth)

23714 ELECTRON SPIN EXCHANGE IN ATOMIC COLLISIONS. Carter, Gary M. (Naval Academy, Annapolis, Md.); Pritchard, David E. Phys. Rev., A; 5: No. 3, 1225-36(Mar 1972).

Electron spin-exchange collisions between an atom with an electron spin of $\frac{1}{2}$ and a target atom with an arbitrary electron spin are considered. The cross sections that describe the collision are expressed in terms of generalized direct and exchange amplitudes and are shown to depend only on the electron spin, polarization, and alignment of the target atom. The effects of an external magnetic field and the nuclear spin of the spin-$\frac{1}{2}$ atom on the collision are included. The cross sections connecting the initial and final states of the free Hamiltonian describing the spin-$\frac{1}{2}$ atom are calculated, with analytic results being displayed for the two limiting cases of the external magnetic field. For the general case, graphical results are presented for several common values of nuclear spin that allow the cross sections to be evaluated for arbitrary magnetic fields. The results are applied to several situations of current interest. (auth)

23715 CALCULATION OF ENERGIES AND WIDTHS OF RESONANCES IN INELASTIC SCATTERING: STABILIZATION METHOD. Fels, Margaret Fulton; Hazi, Andrew U. (Univ. of California, Los Angeles). Phys. Rev., A; 5: No. 3, 1236-49(Mar 1972).

In previous work, the stabilization method of calculating resonance parameters was applied to potential scattering and to elastic scattering from a target. The method is here extended to compound-state resonances in inelastic scattering and its application to a model problem for a target with three bound states is examined. The eigenfunctions associated with eigenvalues ϵ_j obtained from the diagonalization of the exact Hamiltonian in appropriately chosen sets of square-integrable basis functions are good approximations, in the inner region, to particular linear combinations of the degenerate exact scattering solutions at $E = \epsilon_j$ (above inelastic threshold). The partial widths are calculated from a Fermi's-"Golden-Rule"-like formula involving the matrix elements of the exact Hamiltonian between the square-integrable eigenfunctions representing the resonance state and potential-scattering solutions at the same energy. The slowly varying (as a function of E) potential-scattering S matrix, knowledge of which is required in the calculation of the decay widths, is determined using the criterion that several good approximations to the resonance state yield exactly the same widths. For the exactly soluble model problem studied here, the resonance parameters obtained with the stabilization method compare well with the exact values, especially for narrow resonances. The theoretical limitations of the method are discussed. (auth)

23716 SCATTERING OF ELECTRONS BY DIATOMIC MOLECULES. Chandra, Naresh; Joshi, S. K. (Univ. of Roorkee, India). Advan. Astron. Astrophys.; 7: 1-55(1970).

In this review of the theory of electron scattering by molecules, discussions of general theory, the Born–Oppenheimer approximation, the Born approximation, and exchange scattering are followed by separate sections on elastic, inelastic, and resonant scattering. Electron scattering by the hydrogen molecular ion and by dipolar molecules is also considered. (139 references) (A.G.W.)

23717 ELASTIC SCATTERING OF ELECTRONS AND POSITRONS BY HELIUM ATOMS. Banerji, G.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys.; 44: No. 8, 431-7(Aug 1970).

Calculations of differential and total cross sections for the elastic scattering of electrons and positrons by neutral helium atoms were performed over the range of impact energies 50 to 700 eV, employing the Schwinger variational principle for scattering amplitude. The Hartree–Fock static potential for the helium atom was used in the calculations. The results are compared with Born-approximation calculations and with experimental findings. (auth)

23718 TIME DEPENDENT HARTREE–FOCK TREATMENT OF ELASTIC SCATTERING OF ELECTRONS BY H AND He^+. Jamieson, M. J. (Univ. of Exeter, Eng.). J. Phys., B (London); 5: No. 2, L26-30(Feb 1972).

Time-dependent Hartree–Fock theory, in its coupled and uncoupled forms, is used to calculate the elastic singlet p-wave phase shifts for the scattering of electrons by H and He^+. On comparison with the best available results, it is concluded that the coupled scheme, which contains correlation to at least first order, is superior. Levinson's theorem is confirmed. (auth)

23719 NEAR THRESHOLD ELECTRON IMPACT EXCITATION FUNCTIONS FOR THE n = 2 STATES OF HELIUM BY THE TRAPPED-ELECTRON METHOD. Hall, R. I.; Reinhardt, J.; Joyez, G.; Mazeau, J. (Univ., Paris). J. Phys., B (London); 5: No. 1, 66-73(Jan 1972).

The threshold excitation spectrum of helium is presented and discussed. From a series of trapped-electron spectra for increasing well depths, the excitation functions of the four n = 2 states of helium are obtained from threshold to above 22 eV. The inelastic cross section to 23.5 eV was observed and compared with total metastable production measurements. (auth)

23720 ELASTIC SCATTERING OF ELECTRONS BY HYDROGEN AND HELIUM ATOMS. Burke, P. G.; Robb, W. D. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 1, 44-54(Jan 1972).

A recently developed theory of electron scattering by complex atoms based upon the R-matrix method is used to calculate the elastic scattering of electrons by hydrogen and helium atoms. Phase shifts for e^-–H scattering are obtained in the static approximation and also allowing for the atomic polarizability using the pseudostate method. Phase shifts for e^-–He scattering are obtained using both a Hartree–Fock and a correlated target wave function. A discussion is given of why a low-energy e^-–He resonance does not occur in the latter approximation and why probably one does not exist. Finally, the dependence of the phase shift on the number of basis states included in the expansion of the total wave function is discussed and a pseudopotential method is introduced to obtain rapid convergence. (auth)

23721 SIMPLIFIED SECOND BORN APPROXIMATION. Holt, A. R. (Univ. of Essex, Colchester, Eng.). J. Phys., B (London); 5: No. 1, L6-8(Jan 1972).

One approach to the problem of calculating electron–atom or ion–atom cross sections at intermediate energies has been the use of the second Born approximation. The complexity of the resulting calculations has led to the introduction of the simplified second Born approximation (Holt and Moiseiwitsch 1968). Evidence on the accuracy of this approximation is presented. (auth)

23722 SEMIQUANTAL TREATMENT OF HYDROGEN–HYDROGEN EXCITATION AND IONIZATION COLLISIONS. Flannery, M. R. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Phys., B (London); 5: No. 2, 334-45(Feb 1972).

A semiquantal theory is applied to the examination of the excitation and ionization produced by the impact between two hydrogen atoms with incident energies E in the range $0.2 \leq E \leq 2000$ keV. Simultaneous transitions in both the target and the projectile atoms are explicitly acknowledged. The cross sections calculated from the simple semiquantal formulas exhibit remarkable agreement with previous quantal calculations. Also, in certain cases, the velocity distribution of the orbital electron can be neglected and the hydrogen–hydrogen excitation cross sections reduce to simple algebraic expressions, whereas the ionization cross sections involve the numerical evaluation of a one-dimensional integral only. (auth)

23723 ONE-CENTER TWO-ELECTRON INTEGRALS ARISING IN ELECTRON–ION SCATTERING CALCULATIONS. Ramaker, David E. (Univ. of Minnesota, Minneapolis). J. Math. Phys. (N. Y.); 13: No. 2, 161-9(Feb 1972).

The two-electron integrals that arise in electron–ion scattering theory are expressed as a finite sum of terms each involving a generalized hypergeometric function. What is believed to be

the first finite expansion known for the exchange integral is given. The many well-known recursive and transformation features of the hypergeometric functions are then utilized to conveniently and accurately evaluate the integrals with few restrictions on the values of the parameters. (auth)

23724 RADIATIVE TRANSITIONS BETWEEN QUASIMOLECULAR LEVELS DURING ENERGETIC ATOM–ATOM COLLISIONS. Saris, F. W.; van der Weg, W. F.; Tawara, H. (Inst. for Atomic and Moelcular Physics, Amsterdam). Phys. Rev. Lett.; 28: No. 12, 717–20(20 Mar 1972).

The observation of an x-ray band that cannot be identified as a characteristic atomic x ray either of the target atoms or of the projectiles is reported. The new x ray has been observed when 70- to 600-keV argon ions impinge on C, Al, Si, and Fe targets. This x ray is attributed to a radiative filling of a vacancy in the $2p\pi$ orbital of the Ar–Ar system during the collision. (auth)

23725 THEORY OF CHARGE EXCHANGE. Mapleton, Robert A. Wiley-Interscience Series in Atomic and Molecular Collisional Processes. New York; John Wiley and Sons, Inc. (1972). 293p. $19.95.

The approximating methods used to calculate cross sections and probabilities for electron capture from atoms by positively charged atomic particles are described and explained. Different approximate predictions are compared with each other and with experimentally determined values. The material is divided into chapters as follows: quantum mechanical methods for low velocities, quantum mechanical methods for high velocities, classical methods for high velocities, second Born approximation, sundry topics (an approximate classical method for obtaining the cross section for electron capture in alkali metal ion–atom collisions), and comparisons of theoretical and experimental cross sections. (A.G.W.)

23726 MASS AND ION KINETIC ENERGY SPECTRA OF H_2, HD, AND D_2. Beynon, J. H.; Cooks, R. G.; Caprioli, R. M. (Purdue Univ., Lafayette, Ind.). Proc. Roy. Soc. (London), Ser. A; 327: No. 1568, 1–11(22 Feb 1972).

The collision-induced reactions, (1) $H_2^{+*} \rightarrow H^+ + H^*$, (2) $H_3^+ \rightarrow H^+ + H_2$, and (3) $H_3^+ \rightarrow H_2^{+*} + H^*$, and the corresponding reactions of the deuterated species, were examined for their kinetic energy release using a double focusing mass spectrometer. Reaction (1) encompasses two discrete processes, the first apparently involving only the ground electronic state of H_2^+ and the second apparently occurring via excitation to the repulsive first excited state. Isotope effects on the kinetic energy release associated with the transition to the repulsive state in process (1) are consistent with the proposed mechanism. Process (2) gives a "metastable peak", which shows fine structure, possibly due to individual vibrational states of H_2. Reaction (3) occurs by electronic transition to a repulsive state(s). (auth)

23727 PRODUCTION (IN Mg VAPOR) AND LOSS (IN H_2 GAS) OF 1- TO 42-keV/NUCLEON X $^1\Sigma_g^+$ AND c $^3\Pi_u$ HYDROGEN MOLECULES. Morgan, Thomas J.; Berkner, Klaus H.; Pyle, Robert V. (Univ. of California, Berkeley). Phys. Rev., A; 5: No. 4, 1591–1604(Apr 1972).

Collisions that result in the formation and destruction of the $(1s\sigma^2)X^1\Sigma_g^+$ ground state and the $(1s\sigma 2p\pi)c\ ^3\Pi_u$ long-lived electronically excited state of molecular hydrogen were investigated. The molecules were formed by electron capture by 1- to 42-keV/nucleon H_2^+ or D_2^+ ions in Mg vapor. The resulting yields of H_2 ($^1\Sigma_g^+$), $H_2(^3\Pi_u)$, H, and H^+ are reported as a function of Mg-target thickness. Also reported are cross sections for total loss and ionization of the $^1\Sigma_g^+$ and $^3\Pi_u$ states of H_2 in collisions with H_2 gas. (auth)

23728 RESONANCE QUASI-PROJECTION OPERATORS: CALCULATION OF THE ^2S AUTOIONIZATION STATE OF He^-. Temkin, A. (Goddard Space Flight Center, Greenbelt, Md.); Bhatia, A. K.; Bardsley, J. N. Phys. Rev., A; 5: No. 4, 1663–71(Apr 1972).

A method is presented to remedy the defects of the projection-operator technique for calculating electron resonances in scattering from many-electron targets. Specifically it is shown that if the projection operator (i.e., idempotent) Q is replaced by a quasi-projection operator $\hat{Q}$ such that $\lim \hat{Q}\Psi = 0$ as any $r_i \rightarrow \infty$, then the spectrum of $\hat{Q}H\hat{Q}$ is discrete, and can be made to be in essentially a unique correspondence with resonance energies. Relaxation of the idempotency requirement allows us to define two forms of $\hat{Q}$ operator. The simpler of the two forms is tested on e–H and e–He^+ systems; the two lowest resonant energies differ by less than 0.01 eV from rigorous QHQ results. For many-electron targets it is further argued that replacement of the exact target eigenfunction (φ_0) by reasonable approximations ($\bar{\varphi}_0$) in constructing $\hat{Q}$ will affect neither the discreteness of the spectrum $\hat{Q}H\hat{Q}$ nor the proximity of its eigenvalues to the resonant energies. Calculations of He^- using two different (open- and closed-shell) φ_0's and an angle-independent total wave function as well as a configuration-interaction wave function containing up to 40 configurations are carried out. The difference between open- and closed-shell ground-states results is about 0.02 eV, and the latter yields E_{res} (^2S) = 19.363 eV plus a width Γ = 0.014 eV. No other resonances are found below the first excited (2^3S) He threshold. (auth)

23729 ELECTRON TRANSMISSION SPECTROSCOPY: RARE GASES. Sanche, L.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev., A; 5: No. 4, 1672–83(Apr 1972).

A transmission experiment is used to observe structure in the total electron-impact cross section for He, Ne, Ar, Kr, and Xe below the respective ionization potentials and also in the region of autoionizing states. The positions of the resonances are tabulated and compared with the results of other investigators. In both neon and argon, relatively large isolated resonances exist near the edge of the Rydberg series involving inner-shell autoionizing states, i.e., near 47.5 and 29 eV, respectively. (auth)

23730 EFFECTIVE-RANGE THEORY FOR VAN DER WAALS SCATTERING. Ganas, P. S. (California State Coll., Los Angeles). Phys. Rev., A; 5: No. 4, 1684–7(Apr 1972).

The $L > 0$ phase shifts δ_L for low-energy scattering by a van der Waals r^{-6} potential are calculated using the two-potential formula of scattering theory. $Tan\delta_L$ is calculated up to and including the k^{2L+5} lnk term. Results are compared with those obtained using the Born approximation. (auth)

23731 IONIZATION OF K ATOMS IN COLLISION WITH H_2, N_2, O_2, AND CO. Cuderman, J. F. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 5: No. 4, 1687–94(Apr 1972).

Absolute cross sections are reported for the ionization of K atoms having laboratory energies in the range 20 to 1000 eV when interacting with H_2, N_2, O_2, and CO molecules. The range of energies covered, E, and the corresponding cross sections σ_{01} for each of the four target species are as follows: for O_2, $20 < E < 1000$ eV, $8 \times 10^{-19} < \sigma_{01} < 1.1 \times 10^{-15}$ cm^2; for N_2, $50 < E < 1000$ eV, $2.5 \times 10^{-19} < \sigma_{01} < 4 \times 10^{-17}$ cm^2; for CO, $100 < E < 1000$ eV, $2 \times 10^{-19} < \sigma_{01} < 2.3 \times 10^{-17}$ cm^2; for H_2, $150 < E < 1000$ eV, $6 \times 10^{-20} < \sigma_{01} < 8 \times 10^{-18}$ cm^2. (auth)

23732 FORMATION OF FAST EXCITED H ATOMS. I. CHARGE-TRANSFER NEUTRALIZATION OF H^+ IN He AND Ar. Ford, J. C.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 5: No. 4, 1694–1701(Apr 1972).

A study was made of the charge-transfer processes whereby neutral atoms of hydrogen are formed in the 3s, 3p, and 3d states as a result of the impact of protons on targets of helium and argon. Impact energies range from 75 to 400 keV. The experimental procedures involve the quantitative measurement of the Balmer-α radiation emitted by the spontaneous decay of atoms in these three states. The contributions of the three different states are separated by a time-of-flight technique that utilizes the different lifetimes of these states. The cross sections decrease rapidly with increasing energy and are greatest for the state of lowest angular-momentum quantum number. For a helium target, comparisons are made with a Born-approximation prediction; there is a marked discrepancy between theory and experiment for the 3p level but good agreement for the 3s and 3d levels. (auth)

23733 FORMATION OF FAST EXCITED H ATOMS. II. CHARGE-TRANSFER NEUTRALIZATION OF H^+ ON MOLECULAR GASES. Ford, J. C.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 5: No. 4, 1701–4(Apr 1972).

An experimental study was made of the cross sections for forming fast hydrogen atoms in the 3s, 3p, and 3d states by charge-transfer neutralizations of H^+ as it traverses molecular targets. The formation of excited hydrogen was detected by a quantitative measurement of collisionally induced Balmer-α emission; the contributions from the 3s, 3p, and 3d levels were separated by a method that utilizes the different lifetimes of the excited states. Proton-impact energies ranged from 75 to 700 keV; targets included H_2, N_2, NO, O_2, CO, CO_2, CH_4, C_2H_4, C_2H_6, and C_3H_8. Cross sections decreased rapidly with impact energy; the 3s cross section was always largest followed by the 3p and 3d. There was no convincing evidence for a general additive rule whereby cross sections could be assigned to the individual constituent atoms of the molecule and then used to predict cross sections for complex molecules. (auth)

23734 FORMATION OF FAST EXCITED H ATOMS. III. COLLISIONAL DISSOCIATION OF H_2^+ AND H_3^+ ON HELIUM. Ford, J. C.; McCoy, F. M.; Conrads, R.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 5: No. 4, 1705–7 (Apr 1972).

The collisional dissociation of 75- to 700-keV H_2^+ and H_3^+ by impact on targets of He is studied. The formation of excited hydrogen is detected by quantitative measurement of collisionally induced Balmer-α emission; the contributions from 3s, 3p, and 3d levels are separated by a method that utilizes the different lifetimes of the excited states. Cross sections are almost the same for each of the 3s, 3p, and 3d states; they vary slowly with projectile energy. (auth)

23735 ATOMIC DISTORTION AND THE COMBINING RULE FOR REPULSIVE POTENTIALS. Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., A; 5: No. 4, 1708-13(Apr 1972).

The exponential repulsion between atoms, molecules, and ions with closed-shell structure arising from the Pauli exclusion principle is examined in the light of a distortion model. The repulsion energy arises mainly from the distortion of the two atoms, each of which is constrained by the presence of the other to terminate at an intermediate surface, which is often approximately planar. The location of this surface is determined by minimizing the total distortion energy, with the result that the restoring forces in each atom are equal and opposite. There results a new combining rule for these repulsive potentials, allowing the potential for AB to be deduced from those for A_2 and B_2, which reduces in some special cases to the previously assumed geometric-mean rule. A further consequence is a relationship between the instantaneous collisional dipole moments in a family of asymmetric collisions such as HeNe, NeAr, and ArHe, provided that they are all measured at equal values of the collision force. (auth)

23736 REDUCTION METHOD AND DISTORTION POTENTIALS FOR MANY-PARTICLE SCATTERING EQUATIONS. Hahn, Yukap; Watson, K. M. (Univ. of California, Berkeley). Phys. Rev., A; 5: No. 4, 1718-25(Apr 1972).

A general procedure is formulated by which the hierarchy of many-particle scattering equations of the Faddeev types can be reduced systematically to matrix equations of lower dimensions. As illustrations, such reduced sets are derived explicitly for the three-particle system by rearranging different components of the total Green's function. The resulting equations iterate with connected kernels only in the explicit channels. Using the reduction method, the connection between the various versions of scattering equations derived earlier has been exhibited. The effect of implicit channels may be taken into account noniteratively using the channel projection operators. It is also shown that an arbitrary set of distortion potentials may be introduced for the purpose of minimizing the coupling between the rearrangement channels, thus improving the convergence of the multiple-scattering series. (auth)

23737 PHOTODISSOCIATION OF H_2^+ AND D_2^+: EXPERIMENT. von Busch, Friedrich; Dunn, Gordon H. (Univ. of Colorado, Boulder). Phys. Rev., A; 5: No. 4, 1726-43(Apr 1972).

Measurements are reported of the cross sections for photodissociation of H_2^+ and D_2^+ at 21 wavelengths ranging from 2472 to 13,613 Å. The measurements are compared with theory using normalized Franck–Condon factors for the vibrational populations of the ions. Deviations are found, which are interpreted as a failure of this latter approximation. A least-squares analysis of the data yields vibrational-state populations different from simple Franck–Condon factors and alleged to be those characteristic of high-energy electron-impact ionization of H_2 and D_2. Interpretation of the data using a mechanism requiring that a fraction of the ions formed by electron impact be generated via the autoionization channel can qualitatively lead to the observations of this experiment. However, such an explanation would require about $\frac{2}{3}$ of all H_2^+ and D_2^+ to be formed via autoionization—a seemingly unrealistic requirement. Interpretation of the data in terms of a variation with internuclear separation of the electronic matrix element involved in the electron-impact ionization process shows that a matrix element varying as $Q_e(r) = 1 + 0.56(r_{a.u.} - 0.99)^2$ can lead to the experimentally deduced populations of both H_2^+ and D_2^+. This latter interpretation is favored, though one cannot rule out the former or some combination of the two. The data and interpretation are consistent with other related experiments. (auth)

23738 EXCITATION OF THE METASTABLE E $^3\Sigma_g^+$ STATE OF N_2 BY ELECTRON IMPACT. Borst, Walter L. (Southern Illinois Univ., Carbondale); Wells, W. C.; Zipf, E. C. Phys. Rev., A; 5: No. 4, 1744-7(Apr 1972).

The contribution of the $N_2(E\ ^3\Sigma_g^+)$ state to the total metastable excitation function of N_2 was assessed on the basis of previous time-of-flight studies of metastable nitrogen molecules. As a result, the cross section for electron-impact excitation of the $N_2(E\ ^3\Sigma_g^+)$ state was determined in the domain of the resonance from threshold (11.87 eV) to an energy of about 13 eV. The maximum value of the cross section was found to be about 7×10^{-18} cm^2 at an energy of 12.2 eV. The measurement was made absolute by using the previously determined yield of the metastable detector and the lifetime of the E state and by eliminating the energy spread in the electron beam from the primary data. The half-width (full width at half-maximum) of the resonance-like excitation function near threshold was found to be about 0.4 eV. No substantial evidence was obtained from the present data for the presence of the nonresonant part of the excitation function for the E $^3\Sigma_g^+$ state. (auth)

23739 PRECISE HIGH-ENERGY-SCATTERING FACTORS FOR MERCURY. Moore, P.; Fink, M. (Univ. of Texas, Austin). Phys. Rev., A; 5: No. 4, 1747-52(Apr 1972).

Relativistic calculations of the elastic differential cross sections for mercury at 46, 79, and 100 keV are performed using a Liberman (Hartree–Fock–Slater) potential. Various approximations for the exchange of incident and atomic electrons are considered. These calculations explain previous discrepancies between theory and experiment at higher angles. (auth)

23740 OSCILLATORY STRUCTURE IN Li^+–Li CHARGE-TRANSFER CROSS SECTIONS. Dewangan, D. P.; Mukherjee, D. K.; Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., A; 5: No. 4, 1755-8(Apr 1972).

The total cross section for Li^+–Li symmetric charge transfer is considered theoretically by an impact-parameter method using a suitable atomic wave function. This cross section exhibits oscillations and is in qualitative agreement with experimental measurements and other theoretical results based on a simplified two-state theory. (auth)

23741 EXCITATION TO THE 2s STATE OF HYDROGEN BY 20- TO 120-keV HYDROGEN-ATOM IMPACT ON He, Ne, Ar, AND N_2. Hughes, R. H.; Choe, Song-sik (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 5: No. 4, 1758-63(Apr 1972).

Absolute cross sections were measured for the production of hydrogen atoms in the metastable 2s state by fast (20- to 120-keV) ground-state hydrogen-atom impact on He, Ne, Ar, and N_2. The shape of the excitation curve for impact on He is not reproduced by the Born-wave calculation of Levy although the theory curve intersects the experimental curve near the two energy extremes. The scaled Born curves of Levy lie below the experimental curves for impact on Ne and Ar, although there is a general agreement near 20 keV for both gases. Experimental values for the cross sections for production of the 2s and the 2p states by hydrogen-atom impact on the four gases are presented in the range of 1 to 120 keV by combining and weighing the data of Birely and McNeal with the present data where they overlap. (auth)

23742 PROJECTILE z DEPENDENCE OF K X-RAY EMISSION INDUCED BY ALPHA PARTICLES AND DEUTERONS. Lewis, C. W.; Watson, R. L.; Natowitz, J. B. (Texas A and M Univ., College Station). Phys. Rev., A; 5: No. 4, 1773-84(Apr 1972).

Measurements of the yields of K x rays from Cl, Ca, Ti, Ni, and Cu targets and L x rays from Sn and Au targets produced by bombardment with α particles and deuterons of identical velocities were performed at energies from 2.9 to 20 MeV/amu. The ratios of K x-ray yields for the Cl, Ca, Ti, Ni, and Cu targets all show substantial deviations from the ratios expected on the basis of the theoretically predicted z^2 dependence of the Born-approximation and binary-encounter descriptions. The deviations exhibit a "crossover" behavior in which the measured ratios are smaller than expected at low projectile velocities, rise above the expected value at higher velocities, and finally decrease toward the expected value at the highest velocities. The relationship between these deviations and similar deviations in stopping-power measurements has been investigated. Angular distributions of Ti K x rays and Sn K and L x rays were also measured and found to be isotropic to an accuracy of about 2%. (auth)

23743 DIRECT-TRANSITION FEATURES IN STRIPPING COLLISIONS OF HEAVY NEUTRAL ATOMS AND IONS. Fleischmann, H. H.; Dehmel, R. C.; Lee, S. K. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., A; 5: No. 4, 1784-98(Apr 1972).

Previously published experimental data on single-electron stripping for over 100 different neutral–neutral and almost 100 ion–neutral collision pairs are compared with Firsov's statistical ionization model. Reasonable agreement is found for a number of reactions, in particular for collisions between some rare-gas atoms. However, marked disagreement exists for many other collisions. From a model assuming a single-step transition of the ionized electron from the bound state into the continuum, a scaling law is developed semiempirically, which is found able to

reduce a large majority of these published data to within a factor of two of a general cross-section curve. Major disagreements with this model occur only in cases particularly well described by the Firsov model. (auth)

23744 TEMPERATURE DEPENDENCE OF THE HELIUM METASTABILITY-EXCHANGE CROSS SECTION IN THE RANGE 15 TO 115°K. Rosner, S. D.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 5: No. 4, 1909-18(Apr 1972).

An optical-pumping experiment was used to measure the cross sections for the exchange of metastability between ^3He atoms in the $1\ ^1S_0$ ground state and the $2\ ^3S_1$ metastable state in the temperature range from 15 to 115°K. A density-matrix treatment of the ^3He system yields a new relationship between observed linewidth and cross section. (auth)

23745 TOTAL ELECTRON-IMPACT EXCITATION CROSS SECTIONS OF HELIUM. Brongersma, H. H. (Univ., Leiden); Knoop, F. W. E.; Backx, C. Chem. Phys. Lett.; 13: No. 1, 16-19(1 Feb 1972).

Total cross sections for the excitation by electron impact of the 2^3S and 2^1S states of helium are measured in the 19- to 24-eV energy range. Several shape resonances are observed. An estimate for the 2^3P cross section is presented. Close-coupling calculations of Burke et al. predict the correct structure but overestimate the magnitude of the measured cross sections. (auth)

23746 PHYSICS OF ATOMIC COLLISIONS. Second Edition. Hasted, J. B. London; Butterworths (1972). 773 p. £ 20.

A complete revision of this book is presented to cover the new concepts and data that have become available since the first edition of 1964. Chapter headings are as follows: Collisions, populations, energy distributions; theoretical background, classical and quantum; experimental methods employed in collision physics; elastic scattering of electrons by atoms and molecules; excitation of atoms and molecules by electrons; ionization by electrons; positive ion recombination; electron attachment and detachment; photon emission and absorption; elastic collisions between atomic particles; ionization and excitation by atomic particles; charge-transfer processes; collisions of excited species; and chemical interchange collisions. (UK)

23747 VIBRATIONAL STRUCTURE IN ELECTRON SCATTERING BY O_2. Gray, R. L.; Haselton, H. H.; Krause, D. Jr.; Soltysik, E. A. (Univ. of Massachusetts, Amherst). Chem. Phys. Lett.; 13: No. 1, 51-3(1 Feb 1972).

Measurements of the total cross section for the scattering of low-energy electrons (0 to 1.2 eV) by O_2 reveal structure resulting from the formation of the compound negative ion $O_2^- \times {}^2\Pi_g$. From these observations the spectroscopic constants ($2hc\omega_e x_e$ = 3 ± 1 mV, $hc\omega_e$ = 141 mV) are deduced. (auth)

23748 COMPARISON OF VIBRATIONAL TRANSITION PROBABILITIES FOR PENNING IONIZATION AND PHOTOIONIZATION OF NO TO THE $X^1\Sigma^+$ STATE OF NO^+. Brion, C. E.; McDowell, C. A.; Stewart, W. B. (Univ. of British Columbia, Vancouver). Chem. Phys. Lett.; 13: No. 1, 79-81(1 Feb 1972).

Helium metastable atoms were used to study the Penning ionization of NO to the ground state of $NO^+(X^1\Sigma^+)$ with a high resolution electron spectrometer. Vibrational transition probabilities are found to be in excellent agreement with the values obtained from photoionization studies carried out using the 584-A helium resonance radiation. (auth)

23749 COMPARISON OF BOUNDARY-VALUE AND INITIAL-VALUE METHODS FOR THE ACCURATE QUANTUM-MECHANICAL SOLUTION OF THE COLLINEAR REACTIVE SCATTERING PROBLEM. Diestler, D. J. (Purdue Univ., Lafayette, Ind.); Truhlar, D. G.; Kuppermann, A. Chem. Phys. Lett.; 13: No. 1, 1-5(1 Feb 1972).

Quantum-mechanical nonreactive and reactive scattering probabilities determined by two independent numerical methods for the collinear $H + H_2$ reaction on a realistic potential-energy surface are in very good agreement. The results therefore provide a reliable touchstone for other independent calculations. (auth)

23750 EXCITATION OF AUTOIONIZED $^1P^-$ STATES OF A HELIUM ATOM BY FAST ELECTRONS. Lipovetskii, S. S.; Pavlichenkov, A. V.; Polyudov, A. N.; Senashenko, V. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 452-9(Jul-Aug 1971). (In Russian).

The sensitivity of generalized oscillator strengths and of differential and total cross sections for electron excitation of the autoionizing $^1P^{(-)}$ states of He to the form of atomic wave functions is studied in detail. Particular consideration is given to effects of correlation between electrons in the ground state and configuration mixing in excited states. All calculations of inelastic electron scattering were done in the Born approximation. (tr-auth)

23751 ELECTRON-IMPACT EXCITATION OF $3s3p^6nl$ STATES OF Ar. Bolduc, E.; Quemener, J. J.; Marmet, P. (Laval Univ., Quebec). Can. J. Phys.; 49: No. 24, 3095-8(15 Dec 1971).

Clearly resolved structures are reported for the first time in the ionization curve of Ar between 24 and 29.5 eV. The energy and the shape of the excitation cross section for several states were found. The negative-ion state Ar^- ($3s3p^64s^2$) was also detected. (auth)

23752 NEW APPROACH TO NONADIABATIC TRANSITIONS IN COLLISION THEORY. Johnson, B. R.; Levine, R. D. (Ohio State Univ., Columbus). Chem. Phys. Lett.; 13: No. 2, 168-71 (15 Feb 1972).

A practical method for solving the close-coupling problem for electronically nonadiabatic transitions is presented. The present approach combines the separate advantages of adiabatic and diabatic sets by introducing a "crude adiabatic" basis set over limited intervals. The method requires as input the adiabatic potentials and a set of readily computed electronic overlap-type integrals at a discrete number of points. (auth)

23753 EVALUATION OF JACOBIAN DETERMINANTS BY MONTE CARLO METHODS: APPLICATION TO THE QUASI-CLASSICAL APPROXIMATION IN MOLECULAR SCATTERING. La Budde, R. A. (Univ. of Wisconsin, Madison). Chem. Phys. Lett.; 13: No. 2, 154-7(15 Feb 1972).

Sampling techniques have been used previously to evaluate jacobian determinants that occur in classical mechanical descriptions of molecular scattering. These determinants also occur in the quasi-classical approximation. A new technique is described, which can be used to evaluate jacobian determinants that occur in either description. This method is expected to be valuable in the study of reactive scattering using the quasi-classical approximation. (auth)

23754 ION–QUADRUPOLE EFFECTS IN ION–MOLECULE COLLISIONS. Dugan, J. V. Jr.; Palmer, R. W. (Lewis Research Center, Cleveland). Chem. Phys. Lett.; 13: No. 2, 144-9(15 Feb 1972).

Ion-quadrupole effects are investigated via numerical calculations of capture cross sections and computer-plotter studies of ion trajectories in the quadrupole field. Capture cross sections are roughly equal to Langevin values for low rotational temperatures; a large fraction of multiple reflection captures are calculated corresponding to formation of ion–molecule complexes. (auth)

23755 SOLUTION OF THE TWO-STATE POTENTIAL-CURVE-CROSSING PROBLEM. Delos, John B.; Thorson, Walter R. (Univ. of Alberta, Edmonton). Phys. Rev. Lett.; 28: No. 11, 647-9(13 Mar 1972).

A general theory of the two-state curve-crossing problem has been developed, with a complete solution of an accurate model for "close" crossings (including numerical computations for strong coupling). Results clarify the position of the Landau–Zener approximation and its improvements by Nikitin and others, provide a general way of extending these approximations into regions often treated incorrectly (including the high-energy limit), and can be readily adapted to simple, rapid calculations. (auth)

Atomic Theory

Refer also to abstracts 23685, 23710, 24367, and 24713.

23756 CALCULATION OF STARK-MIXING SIGNALS RESULTING FROM A SECOND-ORDER COUPLING IN HYDROGENIC ATOMS. Glass-Maujean, M.; Descoubes, J. P. (CNRS, Paris). Opt. Commun.; 4: No. 5, 345-51(Jan 1972).

The density matrix formalism was used to calculate the changes of the intensity of one spectral line emitted from the levels concerned. It is pointed out that the resonance curves obtained are shifted, distorted, and broadened. (auth)

23757 DETERMINATION OF SCREENING PARAMETERS FROM MEASUREMENTS OF MULTIPLE SCATTERING OF LOW-ENERGY HEAVY PARTICLES. Meyer, L; Krygel, P. (Humboldt Univ., Berlin). Nucl. Instrum. Methods; 98: No. 3, 381-4 (1972).

Starting from a screened Coulomb potential, the screening of which is given by the Thomas–Fermi function $\phi_{TF}(r/a)$, the intensity of forward scattering and the half-width of the scattering distribution are calculated in explicit dependence on the screening parameter a. The multiple scattering of low-energy heavy particles exhibits a distinct dependence of the quantities specified

above on this parameter for small thicknesses of the scattering layer. The quantitative connection is given by two functions, which are tabulated. By means of these functions it is possible to determine the effective screening parameter from measurements of the forward scattering intensity as well as from measurements of the half-width of the scattering distribution. (auth)

23758 INTENSITY FLUCTUATIONS IN MANY-ATOM SPONTANEOUS EMISSION. Ressayre, E.; Tallet, A. (Laboratoire de Photophysique Moleculaire, Orsay, France). Phys. Rev., A; 5: No. 3, 1572-5(Mar 1972).

The normalized two-time intensity-fluctuation functions are calculated for the spontaneous-emission radiation from a system of N two-level atoms. The radiated field, when the system decays from the excited state to the ground state, does not look like a Gaussian or a coherent field. (auth)

23759 NEW SELF-CONSISTENT-FIELD METHOD FOR ATOMS. Vojtik, J.; Kvasnicka, V. (Inst. of Physical Chemistry, Prague). Phys. Rev., A; 5: No. 3, 1568-9(Mar 1972).

The spin-optimized self-consistent-field procedure is generalized for atoms. This new method is flexible, can allow for the angular correlation, and is applicable to the lowest state of any given symmetry type. (auth)

23760 QUANTUM STATISTICS OF SUPERRADIANT PULSES. Haake, Fritz; Glauber, Roy J. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 5: No. 3, 1457-66(Mar 1972).

The statistical aspects of the cooperative emission of radiation by a system of many atoms are investigated. By solving the equation of motion for a suitably defined quasi-probability distribution, which represents the density operator of the atoms, explicit expressions are found for the expectation values of products of atomic observables. The system is found to exhibit large quantum fluctuations for the most highly excited initial states of the atoms. For all others it exhibits nearly classical behavior. Previous numerical evaluations of the radiated intensity and its variance are found to be in good agreement with the present results. (auth)

23761 AUGER TRANSITION RATE IN MIXED-COUPLING SCHEME. El Ibyari, S. N. (American Univ., Cairo); Asaad, W. N.; McGuire, Eugene J. Phys. Rev., A; 5: No. 3, 1048-51 (Mar 1972).

An expression is derived for the Auger transition rate for elements whose initial configuration is described by j–j coupling and whose final configuration is described by Russell–Saunders coupling. Asaad's expression is used for the matrix element when both configurations are described by j–j coupling, and a transformation from j–j to Russell–Saunders coupling is used for the two-electron final-state wave function. In addition expressions are obtained for the M_4NN and M_5NN transitions, which are evaluated in the following paper. (auth)

23762 M-SHELL AUGER AND COSTER–KRONIG ELECTRON SPECTRA. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 5: No. 3, 1052-9(Mar 1972).

Individual-term electron-transition rates for M-shell holes are presented in j–j coupling. As the only available experimental data are best described in the mixed-coupling scheme, further calculations are performed in the mixed-coupling scheme and compared with measured term intensities in Kr and Xe. Agreement is reasonable except for the $(4s, 4p)(^1P_1)$ transition in Kr. A tentative identification is made of the $M_{4,5}N_1N_1$ doublet in Kr and a hypothesis is advanced on the origin of the remaining doublet. (auth)

23763 BEHAVIOR OF ELECTRON WAVE FUNCTIONS NEAR THE ATOMIC NUCLEUS AND NORMALIZATION SCREENING THEORY IN THE ATOMIC PHOTOEFFECT. Pratt, R. H.; Tseng, H. K. (Univ. of Pittsburgh). Phys. Rev., A; 5: No. 3, 1063-72 (Mar 1972).

The behavior of electron wave functions near but outside the atomic nucleus is discussed. It is shown that point-Coulomb shapes persist to quite large distances ($r \cong 5\lambda_e$, where λ_e is the Compton electronic wavelength) for bound states and also for energy-shifted continuum states. The screening effects on continuum-state normalizations cancel the screening effects on the kinematic factor pE in cross sections. These results are used to examine the normalization screening theory in atomic photoeffect, which is characterized by distances both small on an atomic scale and large compared to the size of the nucleus. It is argued that this theory, which describes screening effects simply as a change in normalization, can be good to 1% for photon energies more than 10 keV above the K-shell threshold in Al, 30 keV in Cu, 60 keV in Sn, 150 keV in Pb, and 200 keV in U. This agrees well in order of magnitude with exact numerical calculations. (auth)

23764 FURTHER CALCULATIONS ON MULTIPLE-QUANTUM TRANSITIONS. Chang, C. S.; Stehle, P. (Univ. of Pittsburgh). Phys. Rev., A; 5: No. 3, 1087-92(Mar 1972).

A detailed theory to calculate multiple-quantum transition probabilities is developed. It is shown that the quantum electrodynamical (QED) approach must be used in order to explain quantitatively the experimental observations of Kusch. The anomalous behavior of shifts in resonance frequency and saturation of widths of transition probabilities can be explained on the basis of a QED renormalization principle. In this paper, the detailed calculations for the case of a double-quantum transition are worked out quantitatively. The agreement between QED calculation and Kusch's observation is remarkable. It is concluded that the renormalization principle of QED is important even for low-frequency and finite-intensity fields. (auth)

23765 KINETIC-ENERGY EXPECTATION VALUES WITH DISCONTINUOUS APPROXIMATE WAVE FUNCTIONS. Silverstone, Harris J.; Stuebing, Edward W. (Johns Hopkins Univ., Baltimore). Phys. Rev., A; 5: No. 3, 1092-3(Mar 1972).

The Schlosser–Marcus stationary principle for discontinuous approximate wave functions is shown to be the "finite part" of the energy expectation value. The divergent terms in the expectation value of the kinetic energy are second-order in the discontinuity, which explains why the energy expression obtained when they are omitted remains stationary. (auth)

23766 SUPERRADIANT EFFECTS IN SYSTEMS OF TWO-LEVEL ATOMS. Stroud, C. R. Jr.; Eberly, J. H.; Lama, W. L.; Mandel, L. (Univ. of Rochester, N. Y.). Phys. Rev., A; 5: No. 3, 1094-1104(Mar 1972).

The problem of the evolution in time of a system of two-level atoms coupled through their electromagnetic fields is studied and solved in the framework of semiclassical radiation theory. The atoms may be in any initial states and the radiation reaction is fully taken into account. Both superradiance and time-dependent frequency shift or chirping effects are found. The assumption that all the atoms see the same field is shown to place severe constraints on the evolution of the system, in the form of constants of the motion. These constraints are most easily pictured in terms of the Bloch-vector representation of the atomic system, and they lead to explicit solutions for the time development of each atom. It is shown that the evolution of the complex system is describable by means of a collective super Bloch vector, whose behavior is similar to the behavior of the Bloch vector for a single isolated atom. The constraints on the motion also imply that the system cannot radiate all its energy coherently; some of it remains trapped, to be dissipated ultimately by incoherent processes. Some curves are presented to illustrate the behavior of the system in special cases. (auth)

23767 RELATIVISTIC HARTREE–FOCK–SLATER CALCULATIONS FOR ARBITRARY TEMPERATURE AND MATTER DENSITY. Rozsnyai, Balazs F. (Univ. of California, Livermore). Phys. Rev., A; 5: No. 3, 1137-49(Mar 1972).

An algorithm is presented to calculate electronic levels and the equation of state of atoms suitable for arbitrary matter density and temperature. The self-consistent-field treatment starts with the relativistic Thomas–Fermi–Dirac model in the iterative procedure. The Fermi statistics and the central-field approximation are maintained, giving an average atom representation. The broadening of upper electronic levels into bands is taken into account in a simple approximation. Calculations are presented for the ^{26}Fe and ^{37}Rb atoms at several temperatures and matter densities. (auth)

23768 R-MATRIX THEORY OF ATOMIC POLARIZABILITIES. Allison, D. C. S.; Burke, P. G.; Robb, W. D. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 1, 55-65(Jan 1972).

The frequency-dependent polarizability is written as an expansion in terms of R-matrix states. It is shown that this allows the development of a unified treatment of atomic polarizabilities and photoionization cross sections. A general computer program was written, and this was used to calculate the polarizability of atomic oxygen for imaginary frequency. (auth)

23769 APPLICATION OF NONORTHOGONAL RADIAL ORBITS FOR CALCULATION OF ATOMS AND IONS HAVING CONFIGURATION $1s^22s2p^N$. Kuplyiauskis, Z. I.; Lazauskas, V. M.; Jucys, A. P. (Vilnyus State Univ., USSR). Liet. Fiz. Rinkinys; 11: No. 2, 191-6(1971). (In Russian).

The energies of atoms and ions having the electronic configuration $1s^22s2p^N$ (N = 1, 2, ..., 6) were calculated using the two-exponential analytical radial orbitals. The results are compared with those obtained with the help of hydrogen-like orbitals as well as with results obtained with the help of (orthogonal) solutions of Hartree–Fock equations. (auth)

23770 EXTENDED METHOD OF CALCULATION AND MULTICONFIGURATION APPROXIMATION FOR HELIUM-LIKE ATOMS. Kavetskis, V. I.; Kaminskas, V. A. (Vilnyus State Pedagogical Inst., USSR). Liet. Fiz, Rinkinys; 11: No. 2, 197-202(1971). (In Russian).

A multiconfiguration approximation based on the extended method of calculation is applied to the ground state of helium-like atoms. Two 1sls' analytical two-exponential radial orbitals were used for the ground configuration, hydrogen-like analytical radial orbitals were used for the superposing configurations nl^2 ($0 < l \leq 4$ and $l + 1 \leq n \leq 5$). A 35-configuration approximation was applied to H^-, He, Li^+, Be^{2+}, B^{3+}, and C^{4+}, and the results are given. Theoretical results are compared with experimental data. (auth)

23771 ORBITAL ENERGIES AND KOOPMAN'S THEOREM IN OPEN-SHELL HARTREE–FOCK THEORY. Dodds, J. L.; McWeeny, R. (Univ. of Sheffield, Eng.). Chem. Phys. Lett.; 13: No. 1, 9-12(1 Feb 1972).

In (restricted) open-shell Hartree–Fock theory, the eigenvalues of the effective hamiltonian do not have the usual significance as negative ionization potentials (Koopmans' theorem). By defining orbital energies in terms of certain energy expectation values, it is possible to obtain analogs of Koopmans' theorem and to discuss the energetics of other types of electron transfer. (auth)

23772 CALCULATION OF THE NATURAL WIDTH OF THE SPECTRAL LINES OF THE ATOM BY THE METHODS OF NON-EQUILIBRIUM STATISTICAL MECHANICS. Kuzemsky, A. L.; Walasek, K. (Joint Inst. for Nuclear Research, Dubna, USSR). Lett. Nuovo Cim.; 2: No. 18, 953-6(30 Oct 1971).

In a previous paper the Schroedinger-type equation with damping for a dynamical system weakly coupled to a thermal bath was obtained by a method involving the nonequilibrium statistical operator. The same method is used in this paper to obtain an expression for the natural width of spectral lines of a two-level atomic system interacting with the self-electromagnetic field. The results coincide with results obtained earlier. (A.G.W.)

23773 THOMAS PRECESSION AS EVIDENCE FOR THE NON-EUCLIDEAN GEOMETRY OF ATOMIC ORBITS. Newburgh, R. G. (Air Force Cambridge Research Labs., Bedford, Mass.). Lett. Nuovo Cim.; 3: No. 5, 173-4(29 Jan 1972).

The ideas of Gaussian and Riemannian geometry of surfaces and the experimentally observed Thomas precession are used to demonstrate that the space in which the orbit of an atomic electron lies is not characterized by absolute parallelism and is therefore demonstrably non-Euclidean. (A.G.W.)

23774 LOWER BOUND ON THE EIGENVALUES OF CERTAIN HAMILTONIAN MATRICES. Gallup, G. A. (Univ. of Nebraska, Lincoln). Chem. Phys. Lett.; 13: No. 2, 165-7(15 Feb 1972).

A lower bound is obtained for the eigenvalues of certain matrices arising from the application of the theory of the symmetric groups to the calculation of energy for n-electron systems. (auth)

23775 SHADING OF NUCLEAR CHARGE IN THE ELECTRON SHELLS OF ATOMS ACCORDING TO THE BOHR ATOM MODEL. Kilpi, S. (Helsinki Univ.). Ann. Acad. Sci. Fenn., Ser. A II; No. 156, 1-13(1970). (In German).

The distances of electrons were calculated on the basis of x-ray spectra (of the Critical Tables VI) according to the respective energy equations. The empirically determined factor n/ν was used to produce the unshaded electrostatic nuclear action. (tr-auth)

23776 USE OF GENERAL SPIN ORBITALS IN THE PROJECTED HARTREE–FOCK METHOD. Lunell, S. (Univ. of Uppsala). Chem. Phys. Lett.; 13: No. 2, 93-6(15 Feb 1972).

The spin-projected Hartree–Fock method using general spin orbitals, and in particular its relation to the "best orbital" or spin-optimized self-consistent-field method, is discussed. A simplified method, using S_z-projection only, is also described, and results are presented for different states of the He and Li atoms. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

23777 HYDROMAGNETIC DISTURBANCE PRODUCED BY A MOMENTARY CURRENT IN A SEMI-INFINITE FLUID OF FINITE ELECTRICAL CONDUCTIVITY. Das, K. P. (Jalpaiguri Government Engineering Coll., India). Indian J. Theor. Phys.; 19: No. 4, 131-9(Dec 1971).

The perturbations in velocity and magnetic field due to a momentary and infinitesimal current element in a semi-infinite fluid are derived. The fluid is supposed to be incompressible and finitely conducting. A uniform magnetic field is present perpendicular to its boundary. The results are given in integral form. (auth)

23778 EFFECT OF RADIAL MAGNETIC FIELD ON THE HEAT TRANSFER IN A VISCOELASTIC FLUID IN AN ANNULUS. Tandon, P. N.; Raisinghania, M. D. (H.B.T.I., Kanpur, India. V.S.S.D. Coll., Kanpur, India). Indian J. Theor. Phys.; 19: No. 3, 97-108(Sep 1971).

Approximate analytical solutions are obtained for the heat transfer in a conducting visco-elastic fluid in an annulus of two concentric cylinders in the presence of a radial magnetic field. The fluid is injected at the inner cylinder and withdrawn at the outer cylinder uniformly, and a constant pressure gradient is acting in the direction of the common axis of the cylinders. It was found that, in the absence of suction or injection, the fluid behaves as an ordinary viscous fluid and the increasing values of Eckert and Hartmann numbers have opposite effects on the temperature profile. The Nusselt number is also found to depend on the parameters involved. Some of these results are shown in the tables. (auth)

23779 COUPLING OF MONOCHROMATIC WAVES IN AN ELASTOHYDRODYNAMIC MODEL. Zoler, D.; Deutsch, R. V. Bul. Inst. Politeh. Iasi; 15: No. 1-2, 143-50(1969). (In French).

Certain problems of magnetohydrodynamics are identified with respect to the construction of models for plasmas. One of these involves the study of the elastohydrodynamic behavior of liquid in a rectangular container across which three rubber membranes are stretched. The manner of propagation of a disturbance in the liquid is analyzed and related to the Alfvén wave in a plasma and to slow and rapid magneto-acoustic waves. (Appl. Mech. Rev.)

23780 NONLINEAR RELATIONSHIP OF ELECTROHYDRODYNAMICS AND MAGNETOELASTICITY. Khodzhaev, K. Sh. Prikl. Mat. Mekh.; 35: No. 6, 1038-46(Nov-Dec 1971). (In Russian).

The properties of solutions of the Emden–Fowler equation with a negative degree of an indeterminate function in a nonlinear member were determined. The boundary-value problem in which one of the conditions corresponds to the requirement of the limited solution for the value of the argument, equal to zero or infinity (characteristic of problems in mechanics). The data of the boundary-value problem may have any number and also a countable multiplicity of solutions; to the latter correspond a dependence of solutions on the parameter of a sharply encountered form. For $n > 0$ and also where $n = -2$ (where n is the indeterminate function in a nonlinear member), the Emden–Fowler equation of electrohydrodynamics and magnetoelasticity had been studied in detail previously. One more case was selected for the present article: an equilibrium of heavy filaments with the current, which leads to $n = -1$. Here the nonlinear member may have any value which is consonant with an attraction or repulsion of the fiber. (tr-auth)

23781 TWO-DIMENSIONAL MAGNETIC FIELD IN MAGNETOHYDRODYNAMIC CHANNELS WITH STABLE WALLS FOR FINITE MAGNETIC REYNOLDS NUMBERS. Bertinov, A. I.; But, D. A.; Kovalev, L. K.; Yudas, V. I. Zh. Prikl. Mekh. Tekh. Fiz.; No. 5, 3-11(Sep-Oct 1971). (In Russian).

Distribution of a two-dimensional magnetic field in flow in MHD channels with ferromagnetic walls was investigated. An integral representation constructed for total magnetic induction made it possible to obtain any approximation to a rigorous solution of the problem by computer. The function proposed could be determined for different channels using mirror images and conformal mapping. The method illustrates numerical calculations of the magnetic field distribution during conducting flow along plane ferromagnetic walls and flow in bands between the ferromagnetic walls. Further calculations pertaining to the outer loop and a nonhomogeneous transverse velocity profile for the magnetic field distribution are discussed. (tr-auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 23826, 23836, 23919, and 24281.

Electromagnetic

23782 (CONF-710637-5) ELECTROPRODUCTION OF PIONS AT LOW ENERGIES. Note No. 326. Amaldi, Edorado (Rome Univ. (Italy). Istituto di Fisica). 9 Jul 1971. 62p. Dep. NTIS (U. S. Sales Only).

From Seminar on electromagnetic interactions; Trieste, Italy (21 Jun 1971).

A review is given of the present status of the investigation of the processes $e + p \rightarrow e - p(n) + \pi^0(\pi^+)$ from threshold to slightly above the first resonance. Only the results of coincidence experiments in which one of the two hadrons present in the final state is observed in coincidence with the inelastically scattered electron are considered. (J.F.P.)

23783 KINEMATICS FOR THE DECAY OF π^0 AND K^0 BEAMS. Highland, V. L. (Temple Univ., Philadelphia). Nucl. Instrum. Methods; 98: No. 3, 573-5(1972).

Several simple relations appropriate to the detection of the 2γ decay of a parallel π^0 or K^0 beam are derived. (auth)

23784 COINCIDENCE EXPERIMENT OF INELASTIC ELECTRON–PROTON SCATTERING IN THE REGION OF THE $\Delta(1236)$ AT $q^2 = -0.35$ AND -1.0 (GeV c)^2. Galster, S. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Hartwig, G.; Klein, H.; (and others). Phys. Rev., D; 5: No. 3, 519-27(1 Feb 1972).

Measurements on inelastic electron-proton scattering in the region of the $\Delta(1236)$ resonance are presented for two values of q^2. A fit to the single-arm and the π^0-electroproduction cross sections gave a separation of the resonance and the nonresonant background contribution. The transition form factor $G_M^*(q^2)$ was determined and shown to have a different dependence on q^2 than the magnetic nucleon form factor, confirming earlier measurements. A fit to the angular dependence of the π^0-electroproduction cross section gives some indications that smaller multipole amplitudes contribute to the resonance besides the dominating M_{1+} amplitude. (auth)

23785 BUBBLE-CHAMBER STUDY OF PHOTOPRODUCTION BY 2.8- AND 4.7-GeV POLARIZED PHOTONS. I. CROSS-SECTION DETERMINATIONS AND PRODUCTION OF ρ^0 AND Δ^{++} IN THE REACTION OF $\gamma p \rightarrow p\pi^+\pi^-$. Ballam, J. (Stanford Linear Accelerator Center, Calif.); Chadwick, G. B.; Gearhart, R.; (and others). Phys. Rev., D; 5: No. 3, 545-89 (1 Feb 1972).

Photoproduction is studied at 2.8 and 4.7 GeV using a linearly polarized monoenergetic photon beam in a hydrogen bubble chamber. The experimental procedure, the determination of channel cross sections, and the analysis of the channel $\gamma p \rightarrow p\pi^+\pi^-$ are discussed. A model-independent analysis of the ρ^0-decay angular distribution allows nine independent density-matrix elements to be measured. From these it is found that the reaction $\gamma p \rightarrow p\rho^0$ proceeds almost completely through natural parity exchange for squared momentum transfers $|t| < 1$ GeV^2 and that the ρ production mechanism is consistent with s-channel c.m. helicity conservation for $|t| < 0.4$ GeV^2. A cross section for the production of $\pi^+\pi^-$ pairs in the s-channel c.m. helicity-conserving p-wave state is determined. The ρ mass shape is studied as a function of momentum transfer and is found to be inconsistent with a t-independent Ross–Stodolsky factor. Using a t-dependent parametrization of the ρ^0 mass shape a phenomenological ρ^0 cross section is derived. The phenomenological ρ^0 cross section is compared with other experiments and good agreement is found for $0.05 < |t| < 1$ GeV^2. The discrepancies in the various determinations of the forward differential cross section are discussed. Models for ρ^0 photoproduction are studied and it is found that the Söding model best describes the data. Using the Söding model a ρ^0 cross section is determined. Cross sections and nine density-matrix elements for $\gamma p \rightarrow \Delta^{++}\pi^-$ are determined. The parity asymmetry for Δ^{++} production is incompatible with simple one-pion exchange. Δ^{++} production is compared with models. (auth)

23786 DETERMINATION OF NEUTRON CHARGE WITH THE HELP OF ULTRA-COLD NEUTRONS. Kashukeev, N. T. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 6, 717-19(1971). (In Russian).

Using the common formula for the deviation of a charged particle in a transverse electrical field, it is shown that this deviation depends upon the square of the time of the residence of the particle within this field. For a field of 10^4 V/cm, a deviation of 1 cm, the neutron charge is shown to be of the order of 10^{-20} of the charge on an electron. (K.S.W.)

23787 DOUBLE POSITRON–ELECTRON PAIR CREATION BY PHOTONS: EXPERIMENTAL LIMIT AT $E_\gamma = 6.13$ MeV. Wilkinson, D. H. (Univ. of Washington, Seattle); Alburger, D. E. Phys. Rev., C; 5: No. 3, 719-28(Mar 1972).

A search was made for double positron–electron pair creation by photons of 6.13 MeV. γ rays from the reaction $^{19}F(p,\alpha)^{16}O$ were incident on Ge(Li) detectors of either 15- or 4-cm^3 volume, and the pulse-height spectra were examined for the presence of a four-escape peak. Such a peak was, in fact, observed using the 15-cm^3 detector, but is accounted for by secondary effects, namely, the production of a second pair by bremsstrahlung from the first pair and the direct production of a second pair by the members of the first pair. These secondary effects are evaluated. An upper limit on the cross section for the genuine production of two pairs, σ_2, in one photon–nucleus encounter at 6.13 MeV relative to the formation of a single pair, σ_1, is represented by the experimentally determined ratio $\sigma_2/\sigma_1 = -(2 \pm 5) \times 10^{-5}$; this is consistent with the theoretical expectation of order $(\alpha/\pi)^2$. (7 figures) (auth)

Weak

23788 (COO-2098-1) [SPARK-CHAMBER EXPERIMENT ON $K_{\mu 3}$ DECAY.] Final Report. ([Washington Univ., Seattle]). [nd]. Contract AT(11-1)-2089. 8p. Dep. NTIS.

An analysis is made of the spark chamber experiment on $K^+_{\mu 3}$ decay. The parameters ϵ and Λ_+ are discussed. (J.F.P.)

23789 (IAE-2072) RADIOCHEMICAL METHOD OF NEUTRINO INVESTIGATION USING A PULSED NUCLEAR REACTOR. Borovoi, A. A.; Loboda, S. V.; Chertov, Yu. P. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

A feasibility study was made for studying the reaction $^{19}F + \bar{\nu} \rightarrow {}^{19}Ne + e^-$ using a pulsed nuclear reactor as an antineutrino source. Methods of rapid separation of a small quantity of radioactive atoms of inert gas from a large volume of target material are described in detail. Potassium fluoride solution and fluorobenzene comprised the target materials. A few seconds of time sufficed for extracting radioactive atoms in experiments with labeled atoms. The technique thus developed successfully implemented experiments designed to demonstrate the correctness of the law of conservation of lepton charge. (tr-auth)

23790 EXPERIMENTAL STUDY OF THE TAU MATRIX ELEMENT. Remmel, Ronald Sylvester. Princeton, N. J.; Princeton Univ. (1971). 211p. University Microfilms Order No. 72-2740.

Thesis.

The Dalitz-plot distribution of the first 650,000 tau decays ($K^\pm \rightarrow \pi^\pm\pi^\pm\pi^\mp$) was reconstructed out of 3 million taus detected. A Cherenkov counter identified kaons in a 3.0-GeV/c partially separated beam at the Brookhaven AGS. The directions of all three pions which had given a three-fold coincidence in an eight-counter hodoscope were measured by five wire spark chambers. These chambers and three pairs of chambers behind a wide-aperture magnet served to measure the momentum of the odd pion. A comparable number of Monte Carlo events were used to normalize the data to phase space corrected for Coulomb interactions in the final state. Linear and quadratic fits to the square of the matrix element are obtained in terms of Dalitz–Fabri variables. (Diss. Abstr. Int., B)

23791 K^0 MESON ELECTROMAGNETIC REGENERATION ON PROTONS AND LIGHT NUCLEI AT HIGH ENERGY. Kondratyuk, L. A.; Kopeliovich, V. B.; Solov'ev, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 6, 1237-44(Dec 1971). (In Russian).

Electromagnetic regeneration $K^0_L \rightarrow K^0_S$ on protons and light nuclei at high energy is considered. It is shown that the value of electromagnetic corrections to the amplitude of coherent regeneration on hydrogen may be mainly determined by the contribution of inelastic intermediate states to the γP branch point. The relative contribution of electromagnetic corrections depends on the unitary properties of the vacuum pole and may

achieve 15% at E = 50 GeV and 40% at E = 400 GeV if the P pole does not belong to singlet representation of the SU(3) group. The possibility is discussed to select the contribution of the electromagnetic regeneration in case of the Pomeranchuk theorem violation by comparing the regeneration amplitudes on ^{3}H and ^{3}He nuclei. (auth)

23792 BETA-DECAY OF POLARIZED Λ HYPERONS. I. MEASUREMENT OF THE DECAY RATE. Althoff, K. H.; Brown, R. M.; Freytag, D.; (and others) (CERN, Geneva. Univ., Heidelberg). Phys. Lett.; 37B: No. 5, 531-4(27 Dec 1971).

The branching ratio $R = \Gamma(\Lambda \rightarrow pe\nu)/\Gamma(\Lambda \rightarrow N\pi)$ was measured in a counter-spark chamber experiment in which 1078 ± 11 beta-decays of polarized Λ hyperons were observed. The value $R = (8.4 \pm 0.4) \times 10^{-4}$ is obtained. (auth)

23793 BETA-DECAY OF POLARIZED Λ HYPERONS. II. DETERMINATION OF THE VECTOR AND AXIAL VECTOR FORM FACTORS. Althoff, K. H.; Brown, R. M.; Freytag, D.; (and others) (CERN, Geneva. Univ., Heidelberg). Phys. Lett.; 37B: No. 5, 535-7(27 Dec 1971).

In the analysis of 1078 ± 11 beta decays of polarized Λ hyperons, the asymmetry parameters α_e, α_p, and $\alpha_{e\nu}$ were determined. From these data and the transition rate $\Gamma(\Lambda \rightarrow pe\nu)$ the following values for the form factors were obtained: $g_1/f_1 = 0.62^{+0.09}_{-0.08}$, $f_2/f_1 = 0.89 \pm 0.61$ and $|f_1| = 0.32 \pm 0.02$; $g_2 = 0$ is assumed. The results agree with the Cabibbo theory. (auth)

23794 UNDERGROUND RANGE FLUCTUATIONS OF HIGH ENERGY MUONS FOR VARIOUS ENERGY LOSS PARAMETERS. Kiraly, E.; Kiraly, P.; Osborne, J. L. (Univ. of Durham, Eng.). J. Phys., A (London); 5: No. 3, 444-53(Mar 1972).

The various methods by which the problem of range fluctuations of muons underground can be solved are discussed. Using an analytical solution due to Nishimura (Proc. Int. Conf. on Cosmic Rays, London, 1965, p. 1003) curves are derived from which the enhancement factor due to fluctuations of the underground muon intensity can quickly be obtained, for a wide range of values of the muon energy loss parameters. A survey is given of previously published work in this field and discrepancies are resolved. (auth)

23795 FURTHER RESULTS OF K_{e4} DECAY AND ENERGY DEPENDENCE OF LOW-ENERGY-ππ-PHASE SHIFT. Zylbersztejn, A.; Basile, P.; Bourquin, M.; (and others) (Phys. Lett.; 38B: No. 6, 457-60(20 Mar 1972).

From a study of 1609 K_{e4} decays 1) a test of locality in weak interactions; 2) an evaluation of the energy dependence of the ππ phase shift δ_0^0, and of the scattering length a_0 are presented. (auth)

23796 LATERAL MULTIPLE-SCATTERING DISTRIBUTIONS OF MUONS IN COSMIC-RAY SPECTROGRAPHS. Torsti, J. J. (Turku Univ., Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 385, 1-15(1972).

Analytical recursion formulas are presented for the projected lateral displacement distribution and the projected-angle distribution of the path length and the momentum of a high-energy particle. In the calculations, the solution of the partial differential equation for the multiple-scattering process of fast particles was used. In the theoretical part, which corresponds to the cosmic-ray spectrographs, the effects of energy loss, air gaps, and track-location errors were included. As an application, analytical formulas are given for the lateral positions of the end points of the trajectory in the spectrograph are fixed to be zero. The corresponding experimental lateral distributions of cosmic-ray muons were in agreement with the theoretical requirement of the Gaussian form. The theoretical standard deviations and the experimental root-mean-square values for the scattering displacements were in good agreement with each other in the momentum range 10 to 100 GeV/c, corresponding to the value 21 MeV of the scattering constant. (auth)

Strong (Baryon-induced)

Refer also to abstract 23910.

23797 WIDE-ANGLE PROTON–PROTON ELASTIC SCATTERING FROM 1.3 TO 3.0 GeV/c. Williams, D. T. (Queen Mary Coll., London); Bloodworth, I. J.; Eisenhandler, E.; (and others). Nuovo Cim.; 8A: No. 2, 447-69(21 Mar 1972).

Differential cross sections for proton-proton elastic scattering were measured covering the angular range from 50 to 90° cm at twelve incident momenta from 1.3 to 3.0 GeV/c. The angular distributions are quite smooth, but there is evidence of structure in the energy dependence of fixed-angle cross sections at $|t| \sim 1(\text{GeV})^2$. (auth)

23798 ANTIPROTON–NEUTRON ELASTIC SCATTERING NEAR 1.8 GeV/c. Ma, Z. Ming; Smith, G. A. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 28: No. 12, 779-82(20 Mar 1972).

Antiproton–deuteron inelastic-scattering differential cross sections were measured near 1.8 GeV/c. An impulse approximation is employed to extract antiproton-neutron differential cross sections. The technique allows this reaction to be studied in a low-momentum-transfer region ($0.03 < |t| < 0.15$ GeV^2) never explored before. The data indicate that the real part of the antiproton-neutron forward scattering amplitude is consistent with zero. A comparison of antiproton–proton and antiproton–neutron differential cross sections confirms the previously reported crossover phenomenon in the region of the first diffraction minimum. (auth)

23799 MEASUREMENTS OF THE HADRON INTERACTION CROSS SECTIONS IN COSMIC RAYS. Bashindzhagyan, G. L.; Belokopytov, V. M.; Dem'yanov, A. I.; (and others) (Moscow State Univ.). Yadern. Fiz.; 14: No. 6, 1214-18(Dec 1971). (In Russian).

Cross sections are measured for inelastic interaction of cosmic hadrons with C, Fe, and Pb nuclei at the average energy of ~400 GeV. The interaction lengths in C and Pb were determined from the number of interactions in the thin targets, that in Fe—from the distribution of interaction depths in the ionization calorimeter. (auth)

23800 REVIEW OF EXPERIMENTAL RESULTS ON FEW-BODY REACTIONS AT HIGH ENERGY. Kittel, W. (European Organization for Nuclear Research, Geneva). pp 7-111 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

The total, inelastic and topologic (≥4 prong) cross sections are smooth and constant with energy, in spite of the nonconstant channel cross sections. The channel cross sections behave like two-body cross sections. The exponent n has in general a value of 2. Baryon exchange leads to a faster decrease, but higher energy is needed to see the clear flattening expected for pomeron exchange. Distribution of weighted longitudinal phase (LPS) densities shows strong correlations compatible with "two-system" production. The shape of the distribution varies strongly with energy. Diffraction dissociation is already strong at 10 GeV/c, but higher energy is needed to solve the question of how A_2 or $K^+(1420)$ is produced. Double diffraction dissociation is probably present, but at present energies is largely concealed by meson exchange. Pomeron exchange factorizes to a large degree. Higher energy is needed to show whether the small violation observed in double diffraction dissociation is due to other exchanges. Double pomeron exchange, leading to the production of a ($\pi\pi$) system about at rest in the c.m.s., can neither be unambiguously proved nor ruled out at present energies. Spin-parity and isospin are good tools for the separation of exchange mechanisms operating at present energies and leading to similar longitudinal momentum configurations. Models start to include the proper correlations and to have predictive power for extrapolation to higher energies. The safest way, however, to see what actually happens at higher energies is to do an experiment there. An extrapolation back to present energies will then help to understand these. (auth) (Finland)

23801 EXPERIMENTAL RESULTS ON MANY-BODY REACTIONS. Czyzewski, O. (European Organization for Nuclear Research, Geneva. Inst. of Nuclear Physics, Krakow). pp 115-81 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

The present experimental situation concerning strong interactions at high energy, leading to many-body (≥5) final states is discussed. Specific features of many-body interactions, such as different types of correlations, are reviewed, and present data on multiplicity of created particles are summarized. (TSK) (Finland)

23802 ANALYSIS OF ANGLE AND ENERGY BEHAVIOR OF THE SECONDARY PARTICLES PRODUCED IN NN-INTERACTIONS AT 10 GeV/c. Takibaev, Zh. S.; Antonova, M. G.; Boos, E. G.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 15: No. 1, 62-74(Jan 1972). (In Russian).

Experimental distributions are given of some kinematical characteristics for the secondary nucleons and pions produced in the reactions with a known number of particles in the final state. As the number of pions is increased between 1 and 5, the four momentum distribution of the secondary protons and neutrons is shown to change dissimilarly. A comparison with some theoretical models is made. (auth)

23803 ELASTIC SCATTERING OF ANTIPROTONS ON PROTONS AT 5 GeV/c. EVIDENCE FOR A BACKWARD PEAK. Chabaud, V. (CERN, Geneva); Lehmann, P; Eide, A.; (and others). Phys. Lett.; 38B: No. 6, 449-51(20 Mar 1972).

Antiproton–proton elastic scattering was measured at 5 GeV/c. A total of 30 000 events were observed in the angular range $17° < \theta_{cm} < 136°$, corresponding to $0.3 < -t < 7.7$ $(GeV/c)^2$. In addition to the known dip at $-t = 0.5$ $(GeV/c)^2$, a structure at about $-t = 2$ $(GeV/c)^2$ and a backward peak with a slope 4.1 ± 0.6 $(GeV/c)^2$ were observed. The extrapolated differential cross section at $u = 0$ is 1.3 ± 0.8 $\mu b/(GeV/c)^2$. (auth)

Strong (Meson-induced)

Refer also to abstract 22890.

23804 (CEA-CONF-1957) PRELIMINARY RESULTS ABOUT $\pi^-p \to \pi^0n$ POLARIZATION AT 5 AND 8 GeV/c AND AT LARGE MOMENTUM TRANSFER. Bonamy, P.; Borgeaud, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Bienlein, J. K.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). 1971. 7p. (CONF-710609-11). Dep. NTIS (U. S. Sales Only).

From International conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

Measurements of the polarization parameter of the reaction $\pi^-p \to \pi^0n$ at 5 and 8 GeV/c and for a four momentum transfer t ranging from 0.1 to 2.0 $(GeV/c)^2$, were performed, using a butanol polarized target and detecting only the two γ from the π^0 decay. The background corresponding to bound protons was separately measured and subtracted out. The results obtained agree with Regge predictions involving $\rho + \rho'$ but disagree with Regge models involving cuts. (auth)

23805 (JINR-P1-6188) SLOW π^+- AND π^0-MESON PRODUCTION IN π^+–Xe REACTION AT PRIMARY π^+-MESON MOMENTUM OF 2.34 GeV/c. Slowinski, B. S.; Strugalski, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

Angular and momentum distributions are obtained as well as production cross sections for π^+- and π^0-mesons with the momenta of 50 ± 150 MeV/c, emitted in the $\pi^+ - \chi e$ interactions with a primary π^+-meson momentum of 2.34 GeV/c. (auth)

23806 (JINR-P1-6190) EFFECTIVE MASS SPECTRA OF π^0-MESON AND γ-QUANTUM COMBINATIONS FOLLOWING TWO-PRONG π^+–Xe INTERACTIONS AT THE PION MOMENTUM OF 2.34 GeV/c. Bogdanowicz, J.; Ivanovskaya, I. A.; Kanarek, T.; Ogrzewalski, Z.; Okhrimenko, L. S.; Slowinski, B.; Strugalski, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 32p. (In Russian). Dep. NTIS (U. S. Sales Only).

Distributions of the effective masses of π^0-meson and γ-quantum combinations $M(\gamma\gamma)$, $M(\pi^0\gamma)$, $M(\pi^0\gamma\gamma)$, $M(\pi^0\pi^0)$, $M(\pi^0\pi^0\gamma)$, $M(\pi^0\pi^0\pi^0)$ are given. The content of the background events in the distributions is analyzed. (auth)

23807 (JINR-P1-6228) INVESTIGATION OF THE REACTIONS $\pi^-p \to n\pi^+\pi^- + (1,2,3,4,5)\pi^0$ AT 5 GeV/c. Budagov, Yu. A.; Valkar, S.; Vinogradov, V. B.; (and others) (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Nuclear Problems). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The experimental study of the process $\pi^-p \to n\pi^+\pi^-$ + "neutral particles" at 5 GeV/c with the help of the JINR one meter propane bubble chamber is reported. Partial cross sections of the reactions $\pi^-p \to n\pi^+\pi^- + (1,2,3,4,5)\pi^0$, angular and momentum distributions of the secondary particles in the c.m.s. were obtained. The production of resonant states was investigated. These results are compared with the predictions of various theoretical models. (auth)

23808 (SLAC-141) RHO-MESON PRODUCTION BY PIONS AT 15 GeV/c: A STUDY OF VECTOR DOMINANCE AND OF RHO-OMEGA INTERFERENCE. Ratcliff, Blair N. (Stanford Linear Accelerator Center, Calif.). Dec 1971. Contract AT(04-3)-515. 67p. Dep. NTIS.

Thesis.

The results of a wire spark chamber experiment studying the reaction $\pi^-p \to \pi^+\pi^-n$ at 15 GeV/c are presented. The differential cross section, density matrix elements, and dipion mass distributions are given in the rho region for momentum transfers (t) less than 0.30 $(GeV/c)^2$. The density-matrix elements and differential cross section exhibit structure in the forward direction ($-t < m_\pi^2$). Using the vector dominance model, a comparison is made with polarized and unpolarized single-pion photoproduction data which also exhibit structure in the forward direction. Qualitative agreement with the vector dominance model is found and, in particular, the transverse rho differential cross section displays a pronounced forward peak, analogous to that observed in single-pion photoproduction. Quantitative agreement is found for the unnatural-parity-exchange cross section and for the asymmetry at small momentum transfers. Elsewhere there are disagreements in detail which may not be explained by changes in normalization or the value of the rho-photon coupling constant. The data show a significant (>4 standard deviations) rho-omega interference effect in the dipion mass distribution for $0.1 < |t| < 0.3$ $(GeV/c)^2$. The overall phase between the amplitudes in the observed data is dominated by transverse production and is shown to be -1.40 ± 0.45 (rad) which differs from the phase found at lower energies by $\simeq -\pi/2$. The lower limit on the branching ratio $\Gamma(\omega \to 2\pi)/\Gamma(\omega \to 3\pi)$ is 0.7% at the 95% confidence level. (auth)

23809 MEASUREMENT OF $(\pi^\pm, {}^4He)$ ELASTIC SCATTERING AT 97 MeV WITH A HIGH-PRESSURE STREAMER CHAMBER. Falomkin, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR); Kulyukin, M. M.; Lyashenko, V. I.; (and others). Lett. Nuovo Cim.; 3: No. 11, 461-6(11 Mar 1972).

Preliminary results obtained from measurements of the differential cross section for π^- and π^+ elastic scattering on ^4He at 97 MeV are reported. Details are given on the experimental set-up using a high-pressure streamer chamber. A comparison of data from different experiments shows significant discrepancies, thus an estimate for the electromagnetic form factor of the pion is not obtained. (L.B.S.)

23810 STUDY OF THE FINAL STATES $\pi^-\pi^-p\bar{K}^0$, $\pi^-\pi^-p\bar{K}^0\pi^0$, AND $\pi^-\pi^-\pi^+K^0n$ PRODUCED IN K^-n INTERACTIONS AT 4.91 GeV/c. Price, Ronald Rhoads. Nashville; Vanderbilt Univ. (1971). 258p. University Microfilms Order No. 72-3232.

Thesis.

Resonance production in the reactions containing a proton in the final state was characterized primarily by the production of $K^{*-}(890)$. The events with a final state neutron were characterized by the production of either $K^{*-}(890)$ or $N^{*-}(1236)$, but very little double resonance production. Cross sections are presented. Exponential slopes for the momentum-transfer distributions of the $K^{*-}(890)$ and $N^{*-}(1236)$ were determined. For the four-constraint events the spin density matrix elements for the decay of the $K^{*-}(890)$ in the Jackson frame implied alignment. These data from all three reactions were compared with the predictions of the multiperipheral model of Chan, Loskiewicz, and Allison (CLA) as modified to include resonance production by Bassompierre, et al. The data from the four-constraint events are also compared with the multiperipheral model of Plahte and Roberts. Evidence for the possible production of an isospin 5/2, strangeness zero baryon enhancement is present. (Diss. Abstr. Int., B)

23811 MESON AND STRANGE BARYON PRODUCTION IN A BUBBLE CHAMBER TRIGGERED ON PROTONS OR K^+ MESONS FROM NEGATIVE PI MESONS INCIDENT ON HYDROGEN AT 2.45 GeV/c. Buhl, Thomas Edward. Madison, Wis.; Univ. of Wisconsin (1971). 136p. University Microfilms Order No. 71-28,979.

Thesis.

The Rapid-Cycling Bubble Chamber at the Princeton-Pennsylvania Accelerator was exposed to a π^- beam at a momentum of 2.45 GeV/c and triggered on either 1) final state protons or K^+'s that were forward in the center of mass and fast in the laboratory, or 2) protons on the Jacobean Peak in the A_2 mass range. 252,000 pictures were taken during 2.58 million accelerator pulses at 5.9 π's/pulse. The production of the ρ^-, A_1^-, A_2^-, and B^- through baryon exchange, as well as the production of the $\Sigma^-(1197)$ and $\Sigma^-(1385)$ in the Q = 2 meson exchange region, was observed in the events in trigger 1). The $\Sigma^-(1385)$ was found to be 20 times more strongly produced than the $\Sigma^-(1197)$. In the events in trigger 2), a 3.8 standard deviation split in the A_2 meson was observed at a momentum transfer of $.6 < |t| < .78$. (Diss. Abstr. Int., B)

23812 STUDY OF THE REACTIONS $K^-N \to \pi^-\pi^-\pi^+\Lambda$, $K^-N \to \pi^-\pi^-\pi^+\Sigma^0$, AND $K^-N \to \pi^-\pi^-\pi^+\pi^0\Lambda$ AT 4.9 GeV/c. Berg, Ronald Elden. Nashville; Vanderbilt Univ. (1971). 183p. University Microfilms Order No. 72-3203.

Thesis.

The reactions (1) $K^-N \to \pi^-\pi^-\pi^+\Lambda$, (2) $K^-N \to \pi^-\pi^-\pi^+\Sigma^0$, and (3) $K^-N \to \pi^-\pi^-\pi^+\pi^0\Lambda$ at a beam momentum of (4.910 ± 0.007) GeV/c were studied. The cross sections for these reactions and for resonance production in them were measured. The observed single particle production angular distributions show good qualitative but not quantitative agreement with the Reggeized multiperipheral model of Chan, Loskiewicz, and Allison. Strong disagreement was found between the amounts of observed resonance production and the multiperipheral model of Plahte and Roberts that is based on the models of Chan et. al., and Veneziano. However isospin effects are included only in an approximate manner. (Diss. Abstr. Int., B)

23813 SINGLE AND DOUBLE CHARGED PION PRODUCTION PROCESSES IN 25 GeV/c π^-p INTERACTIONS. Robertson, William John. Madison, Wis.; Univ. of Wisconsin (1971). 143p. University Microfilms Order No. 71-29,011.

Thesis.

The $\pi^-\pi^+$n and $\pi^-\pi^-\pi^+$p kinematic fits were studied from an analysis of a 100,000 picture exposure of 25 GeV/c π^- in the BNL 80-inch HBC. Two and three body invariant mass spectra and the associated angular and momentum transfer distributions are presented. The production cross sections are calculated for each process studied. From the $\pi^-\pi^+$n and $\pi^-\pi^-\Delta^{++}$ final states $\pi\pi$ scattering using OPE techniques was studied. Particular emphasis was placed on the study of the dipion invariant mass region above 2 GeV/c^2. The $\pi\pi$ scattering becomes diffractive and the elastic and total cross sections become constant, or nearly so, with $\sigma^{el} \doteq$ 1.5 mb. and $\sigma^{tot} \doteq$ 15 mb. above dipion invariant masses of 3 GeV/c^2, for both $\pi^-\pi^+$ and $\pi^-\pi^-$ scattering. The diffractive $\pi\pi$ scattering above the resonant region thus appears to become I-spin independent. From a study of the $\pi^-\pi^-\pi^+$ system evidence is found for A1(1^+) and A2(2^+) decaying into $\pi\rho$, and A3(2^-?) decaying into πf^0. All of these enhancements are attended by a large, predominantly $\pi\rho$ S wave, diffractive background. A J^P analysis of the A meson region is done and cross section estimates are made. Peaking at low π^+n and $\pi^-\pi^+$p invariant masses is observed, and is primarily attributable to diffractive $\pi\pi$ scattering from an OPE process. Above this background evidence is seen for N*(1500) and N*(1700) baryon resonance formation. Where possible, the results are compared to similar investigations conducted at lower momenta. (Diss. Abstr. Int., B)

23814 A3 REGION OF THE THREE-PION MASS SPECTRUM IN THE REACTION π^-p → p$\pi^+\pi^-\pi^-$ AT 13 AND 20 GeV/c. Harrison, W. C.; Heyda, D.; Johnson, W. H.; (and others) (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 28: No. 12, 775-9 (20 Mar 1972).

An investigation of the production channels of the A3 region of the $\pi^+\pi^-\pi^-$ mass spectrum from the reaction π^-p → p$\pi^+\pi^-\pi^-$ at 13 and 20 GeV/c is reported. Evidence that the A3 has a substantial branching ratio to 3π is obtained; its mass and width are measured as 1658 ± 8 MeV and 53^{+30}_{-16} MeV, respectively. To satisfactorily describe the data an additional peak is required with mass 1830 MeV and width 130 MeV. (auth)

23815 $\pi^\pm$-PROTON ELASTIC SCATTERING AT 180° FROM 0.60 TO 1.60 GeV/c. Rothschild, R. E.; Bowen, T.; Caldwell, P. K.; (and others) (Univ. of Arizona, Tucson). Phys. Rev., D; 5: No. 3, 499-505(1 Feb 1972).

The differential cross section for $\pi^\pm$-p elastic scattering at 180° was measured from 0.572 to 1.628 GeV/c using a double-arm scintillation-counter spectrometer with an angular acceptance θ^* in the center-of-mass system defined by $-1.00 \leq \cos\theta^* \leq -0.9992$. The π^+-p cross section exhibits a large dip at 0.737 GeV/c and a broad peak centered near 1.31 GeV/c. The π^--p cross section exhibits peaks at 0.69, 0.97, and 1.43 GeV/c. (auth)

23816 COHERENT K^+d INTERACTIONS AT 12 GeV/c. Firestone, A.; Goldhaber, G.; Lissauer, D.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 3, 505-19(1 Feb 1972).

A study was made of the coherent reactions $K^+d \to K^+\pi^+\pi^-d$ and $K^+d \to K^0\pi^+d$ at 12 GeV/c, using data obtained in the SLAC 82-in. bubble chamber. The cross sections for these two processes are 331 ± 35 and 19 ± 4 μb, respectively. The reaction $K^+d \to K^+\pi^+\pi^-d$ is dominated by Q production in the $K\pi\pi$ system. The shape of the Q enhancement is nearly identical to that observed in the reaction $K^+p \to K^+\pi^+\pi^-p$ at similar energies. This result may be interpreted in terms of mixing between the strange members of the A_1 and B nonets. There are also an L signal at M($K\pi\pi$) ~ 1.72 GeV and a d* signal at M($d\pi^+$) ~ 2.2 GeV. The L appears to be formed primarily in conjunction with the d*, with the π^+ meson shared between the two of them. The reaction $K^+d \to K^0\pi^+d$ is dominated completely by K*(890) production. (auth)

23817 POSSIBLE EXISTENCE OF THE $\pi^-\gamma$ RESONANCE AT 270 MeV. Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 6, 1201-5(Dec 1971). (In Russian).

An experimental indication was obtained of the possible existence of a new resonance: in the $\pi^-\gamma$ effective mass spectrum produced in the reaction π^-p → p + ($\pi^-\gamma$) + mπ^0, m ≥ 1 at P_{π^-} = 5 GeV/c. A narrow peak was observed at $M_{\pi\gamma}$ = 270 ± 5 MeV with an excess of 5.2 ± 0.4 standard deviations over the background curve. The experiment was performed using the one meter propane bubble chamber of Joint Institute for Nuclear Research. (auth)

23818 TWO Λ^0-HYPERON PRODUCTION IN INTERACTIONS OF π^--MESONS WITH CARBON NUCLEI AT 5 GeV/c. Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern, Fiz.; 15: No. 1, 75-80(Jan 1972). (In Russian).

The results are reported of investigations of four strange particle production in cascade interactions of π^--mesons with carbon nuclei at 5 GeV/c. The total Λ^0-hyperon production cross section is 98.1 ± 17.3 μb. Anomalies are observed in the number and spectra of the produced Λ^0-hyperons. (auth)

23819 STUDY OF THE CHARGE EXCHANGE PROCESS $K^+n \to K^0p$ AT 10 GeV/c. Haguenauer, M. (Ecole Polytechnique, Paris); Mine, P.; Nguyen-Khac, U.; (and others). Phys. Lett.; 37B: No. 5, 538-40(27 Dec 1971).

A study of the charge exchange reaction $K^+n \to K^0p$ using 10-GeV/c K^+ interactions on nuclei is presented. The differential cross section is compared with that of the reaction $K^-p \to K^0n$. The total cross section is estimated to be 76 ± 13 μb per nucleon which agrees with the SU3 prediction. (auth)

23820 RAPIDITY CORRELATIONS BETWEEN THE NEGATIVE PIONS PRODUCED IN THE K^+p INTERACTION. Ko, Winston (Univ. of California, Davis). Phys. Rev. Lett.; 28: No. 14, 935-8(3 Apr 1972).

Dramatic behavior is observed in the correlation between π^-'s as a function of their rapidity separation Δy. At small Δy, the π's are strongly positively correlated. At large Δy the correlation length is measured to be 0.52 ± 0.03. Particle-production and particle-particle correlations are distinguished and studied. (auth)

23821 OBSERVATION OF A CROSSOVER IN THE DIFFERENTIAL CROSS SECTIONS FOR Q-MESON PRODUCTION. Brandenburg, G. W.; Johnson, W. B.; Leith, D. W. G. S.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 28: No. 14, 932-5(3 Apr 1972).

A crossover is observed in the differential cross sections for the inelastic processes $K^0p \to Q^0p$ and $\overline{K}^0p \to \overline{Q}^0p$, from $K^\pm_{1,2}p$ data in the momentum range from 4 to 12 GeV/c. This phenomenon is evidence that Regge, in addition to Pomeranchukon, exchanges contribute to Q-meson production. (auth)

23822 TRANSMISSION REGENERATION OF NEUTRAL K-MESONS ON HYDROGEN IN THE MOMENTUM REGION OF 14 TO 42 GeV/c. Birulev, V. K.; Fadeev, N. G.; Golovanov, L. B.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of High Energy Physics, Serpukhov, USSR. Central Inst. of Physical Research, Budapest). Phys. Lett.; 38B: No. 6, 452-6 (20 Mar 1972).

The measurements of the transmission regeneration amplitude on hydrogen in the momentum region of 14 to 42 GeV/c indicate that in accordance with the Pomeranchuk theorem its magnitude $|f^0 - \bar{f}^0|/k$ decreases as energy increases and its phase is approximately constant and equal to arg $(f^0 - \bar{f}^0) = (-118 \pm 13)^0$. (auth)

23823 K^+p ELASTIC SCATTERING AT 5 GeV/c. EVIDENCE FOR A K^-p BACKWARD PEAK. Chabaud, V. (CERN, Geneva); Eide, A.; Lehmann, P. Phys. Lett.; 38B: No. 6, 445-8 (20 Mar 1972).

The elastic scattering of $K^\pm$ mesons on protons was studied at 5 GeV/c. A total of about 500 000 events were measured in the c.m. angular range $17^0 < \theta_{cm} < 165^0$ corresponding to $0.2 < -t < (\text{GeV/c})^2$. A K^-p backward peak was observed which was parametrized as $d\sigma/du = (0.6 \pm 0.2)\exp[(3.3 \pm 0.6)u]$ μb/(GeV/c)^2, while for the K^+p backward peak $d\sigma/du = (17.5 \pm 1)\exp[(3.6 \pm 0.2)u]$ μb/(GeV/c)^2 was found. The K^-p cross section falls to about 0.03 μb/(GeV/c)^2 around $-t = 5$ (GeV/c)^2, while the K^+p cross section stays in the vicinity of 0.3 μb/(GeV/c)^2 in the same t-region. The K^+p and K^-p differential cross sections have cross-over points at $-t = 0.2$, 1.1 and about 3.5 (GeV/c)^2. (auth)

23824 MEASUREMENT OF LARGE-ANGLE $\pi^\pm$p ELASTIC SCATTERING AT 5 GeV/c. Chabaud, V. (CERN, Geneva); Eide, A.; Lehmann, P.; (and others). Phys. Lett.; 38B: No. 6, 441-4(20 Mar 1972).

The differential cross section for 5 GeV/c π^+p and π^-p elastic scattering was measured in the c.m. angular region $27^0 < \theta_{cm} < 130^0$ corresponding to $0.5 < |t| < 7.8$ (GeV/c)^2. Dips are observed in both reactions at $-t = 2.8$ and 4.8 (GeV/c)^2 where the cross sections are approximately 0.1 μb/(GeV/c)^2. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 24350.

General

Refer also to abstracts 23966, 23974, and 23989.

23825 (COO-3285-21) RESEARCH IN THEORETICAL PHYSICS. Annual Report, April 1, 1971–March 31, 1972. Domokos, Gabor (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Dec 1971. Contract AT(11-1)-3285. 20p. Dep. NTIS.

Research on hadron structure determined in semileptonic processes and a light-like formulation of hadron dynamics is summarized. A list of publications issued during the period is appended. (J.F.P.)

23826 (COO-3505-1) REPORT OF TECHNICAL PROGRESS. Pais, A. (Rockefeller Univ., New York). [1971]. Contract AT-(11-1)-3505. 14p. Dep. NTIS.

A summary of theoretical and experimental research on scaling and other properties of inelastic lepton–nucleon scattering, hadronic scaling, chiral symmetry breaking, electromagnetic and weak interactions, and miscellaneous topics is presented. A list of publications is included. (J.F.P.)

23827 QUANTUM PARTICLE DYNAMICS. Puranik, P. G. New Delhi; S. Chand and Co. (Pvt.) Ltd. (1971). 323p. Rs. 25.00.

The topics discussed are special relativity theory, relativistic mechanics and electrodynamics, operators, eigenfunctions, eigenvalues, the Schroedinger wave equation, quantum mechanics of simple cases, angular momentum, the hydrogen atom, and quantum mechanical operators. Also treated are scattering theory, Heisenberg matrix mechanics, electron spin, perturbations and radiation theory, the Dirac equation, quantization of the electromagnetic field, high energy electromagnetic events, and nuclear forces. (J.F.P.)

23828 CALCULATION OF THE MASSES OF ELEMENTARY PARTICLES. Akulov, N. S. (Dept. of Physics of Nondestructive Testing, Minsk). Dokl. Akad. Nauk SSSR; 200: No. 1, 60-3(1 Sep 1971). (In Russian).

The pre-decomposition state of hadrons when they consist of unbonded fermions (reons) and are being converted into decay leptons is discussed. A tabulation of structures, masses, and pathways and energies of decay for 12 elementary particles is offered. (K.S.W.)

23829 INCLUSIVE APPROACH TO UNITARITY. Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Phys. Rev. Lett.; 28: No. 9, 578-80 (28 Feb 1972).

A linear sum rule is proposed for inclusive-type discontinuities, and its equivalence to the basic discontinuity equation recently derived by Cahill and Stapp is proven. This, in turn, is believed to be equivalent to unitarity. The possibility of formulating an "inclusive bootstrap" is pointed out. (auth)

23830 DEPENDENCE OF MULTIPLICITY ON RECOIL MOMENTUM IN HIGH-ENERGY COLLISIONS. Webber, B. R. (Univ. of California, Berkeley). Lett. Nuovo Cim.; 3: No. 10, 424-6 (4 Mar 1972).

It is pointed out that for investigating multiplicities of secondaries in multiparticle production processes at very high energies some two-particle correlation ranges can be determined by a measurement of one low-momentum track, namely, that of the recoiling target particle, in conjunction with a simple count of the number of charged secondaries produced. Some related predictions concerning the results of this kind of measurement are also discussed. (L.B.S.)

23831 INCLUSIVE- AND EXCLUSIVE-CROSS-SECTION FUNCTIONALS: CONSERVATION CONSTRAINTS AND MULTIPLICITY DISTRIBUTIONS. Brown, Lowell S. (Imperial Coll. of Science and Tech., London. Univ. of Washington, Seattle). Phys. Rev., D; 5: No. 3, 748-55(1 Feb 1972).

A generating functional is constructed that relates inclusive and exclusive multiparticle cross sections. In a special case it reduces to the generating function of the multiplicity distribution. The generating functional is used to derive the complete set of constraints imposed by energy-momentum and charge observation. The nature of these constraints in the high-energy limit is discussed. It is shown that, if there is no correlation between a pair of pions of the same charge, then the width of the multiplicity distribution of all charged pions should be about twice that of a Poisson distribution, a result in good agreement with present experiment. It is also conjectured that, in the high-energy limit, the leading terms of all the moments of the multiplicity distribution of a particular produced particle become independent of the production mechanism. (auth)

23832 ENERGY INDEPENDENCE OF INCLUSIVE REACTIONS. Logan, R. K. (Univ. of Toronto). Phys. Rev., D; 5: No. 3, 782-3(1 Feb 1972).

The question of the energy dependence of inclusive reactions such as $a + b \rightarrow c +$ anything is discussed. Factorization arguments are used to show that the condition that $ab\bar{c}$ and ab be exotic for energy independence leads to the energy independence of a number of nonexotic reactions. It is suggested on the basis of simple Regge-exchange diagrams that perhaps a sufficient condition for energy independence, when b fragments into c, is that $ab\bar{c}$, ab, and $a\bar{c}$ be exotic. (auth)

23833 SPIN DEPENDENCE IN INCLUSIVE REACTIONS. Abarbanel, Henry D. I.; Gross, David J. (Princeton Univ., N. J.). Phys. Rev., D; 5: No. 3, 699-709(1 Feb 1972).

The spin dependences of high-energy inclusive reactions are treated from the viewpoint of a J-plane analysis. Measurements of various spin correlations are shown to bear directly on questions such as factorization of residues at Regge poles and the strengths of J-plane cuts. Examples of experiments which test these ideas using polarized beams, polarized targets, or polarized products are provided. Electroproduction and high-energy neutrino reactions are viewed as sources for polarized spin-one "beams," and the implications for the processes are drawn in detail. Finally, scaling properties of these latter reactions are considered and produced-particle multiplicity in the scaling region is discussed. (auth)

23834 HOW TO EXPRESS PRODUCTION AMPLITUDES IN EXCEPTIONAL REGIONS. Wang, Kuo-hsiang (Pennsylvania State Univ., University Park). Phys. Rev., D; 5: No. 3, 690-3 (1 Feb 1972).

A study is made for representations of a production amplitude in exceptional regions inside the physical region. It is found that a complete set of independent invariant variables is not sufficient to describe production processes involving more than five external particles, in the exceptional regions. The result not only influences kinematic singularities as well as the meaning of analyticity of production amplitudes, but also provides a guideline for proposing models and for fitting data. An approach, related to some of these problems, is suggested so that particle distributions for inclusive reactions can be studied with the multi-Regge expansions for all coupling schemes (configuration diagrams). (auth)

23835 LETNYAYA SHKOLA PO PROBLEMAM TEORII ELEMENTARNYKH CHASTITS, OTEPYA, AVGUST 1967. II CHAST'. PROBLEMY CP-SIMMETRII (PRODOLZHENIE). (Summer School on Problems in the Theory of Elementary Particles, Otepaa, August 1967. Part II. Problem of CP-Symmetry (Continued)). Ainsaar, A. (ed.). Tartu; Institut Fiziki i Astronomii (1970). 100p.

This volume contains three lectures from the series held at the Institute of Physics and Astronomy, Otepaa. The T-odd angular correlations in cascade gamma-transitions of nuclei are discussed. Neutral currents in the theory of weak interactions are examined from three points of view: the requirements for the Hamiltonian structure of weak interaction, the interaction of such currents, and interactions prohibited by the fixed Hamiltonian structure without neutral current interaction. The hypothesis of partial conservation of the axial current is discussed. (K.S.W.)

23836 COLLOQUIUM ON MULTIPARTICLE DYNAMICS. Proceedings Held at Helsinki, Finland, May 25–28, 1971. Byckling, E.; Kajantie, K.; Satz, H.; Tuominiemi, J. (eds.). Helsinki; University of Helsinki (1971). 463p. (CONF-710519).

The rapporteurs' talks from the eight sessions are presented. A list giving the authors and titles of all the papers submitted to the colloquium is included. Seven talks are abstracted individually. One talk was abstracted previously in NSA. For an abstract see 25: 1485. (Finland)

For abstracts of individual papers see: 23800–23801, and 23910–23914.

23837 FACTORIZATION AND EXCHANGE DEGENERACY OF SECONDARY TRAJECTORIES IN INCLUSIVE REACTIONS. Miettinen, H. I. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 38B: No. 6, 431-4(20 Mar 1972).

Some predictions following from factorization and exchange degeneracy of secondary trajectories in inclusive reactions are tested and discussed. (auth)

23838 INTERNAL SYMMETRIES AND MODEL-INDEPENDENT RELATIONS FOR INCLUSIVE PROCESSES. Lipkin, H. J. (Argonne National Lab., Ill. National Accelerator Lab., Batavia, Ill.); Peshkin, M. Phys. Rev. Lett.; 28: No. 13, 862-5(27 Mar 1972).

Symmetries restrict isospin and SU(3) dependence of single-particle and multiparticle inclusive and semi-inclusive cross sections. Isospin relations test treatments of experimental data, including deuteron corrections, $\Lambda-\Sigma^0$ separations, and resonance-background separations. They also test the isospin structure of

initial states in photoproduction, electroproduction, and neutrino-production processes; and they can reveal Coulomb effects in $\bar{p}d$ or $\bar{p}\alpha$ annihilation. Applied separately to beam and target fragments, they test diffractive excitation models. (auth)

23839 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 5, 1972. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 91p.

23840 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 4, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 71p.

Electromagnetic

23841 (DESY-71/65) ON THE t-CHANNEL DESCRIPTION OF DEEP INELASTIC ELECTROPRODUCTION. Pallua, S.; Renner, B. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov 1971. 5p. Dep. NTIS (U. S. Sales Only).

Attention is drawn to the fact that a description of deep inelastic electroproduction in terms of nonexotic t-channel exchanges puts stringent constraints on the data. It puts a bound on the ratio of neutron and proton structure functions $|F_{\gamma N}(\omega)/F_{\gamma p}(\omega)| \geq 1/4$, equality being reached with asymptotically vanishing contributions from SU_3 decuplet nucleon resonances in the direct channel. Further implications are found on the Drell-Yan relation between the asymptotic behavior of the nucleon electromagnetic form factor and the dependence of the nucleon structure function on the Björken scaling variable near threshold. (auth)

23842 (DESY-71/66) SCALING BEHAVIOUR IN OFF-SHELL PHOTON-PHOTON SCATTERING. Walsh, T. F.; Zerwas, P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec 1971. 9p. Dep. NTIS (U. S. Sales Only).

Some of the theoretical questions which can be studied in the reaction $e + e \rightarrow e + e +$ hadrons where the electrons are scattered with large momentum transfer are investigated. The even-charge conjugation part of this reaction is determined by the off-mass shell behavior of the amplitude $\gamma^* + \gamma^* \rightarrow$ hadrons. At fixed hadron mass, there exists a scaling relation for this amplitude in terms of the virtual photon masses. When the hadron mass becomes large, parton models and bilocal algebras yield definite predictions for the absorptive part of the forward virtual photon-photon scattering amplitude. The colliding beam cross sections which result are of order 10^{-36} cm^2. (auth)

23843 (DESY-71/67) THREE PION PRODUCTION IN ELECTRON COLLIDING BEAMS. Koeberle, R. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec 1971. 8p. Dep. NTIS (U. S. Sales Only).

The total cross section for the reaction $ee \rightarrow ee\,3\pi$ is calculated in a model, which includes ρ and σ mesons, and incorporates gauge invariance and the hypothesis of the partially conserved axial vector current. (auth)

23844 (DESY-71/68) ANALYSIS OF PHOTO AND ELECTROPRODUCTION DATA AGAINST ω_W. Brasse, F. W.; Chazelas, E.; Fehrenbach, W.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec 1971. 20p. Dep. NTIS (U. S. Sales Only).

A detailed analysis is made of scaling and local duality of the two structure functions W_1 and νW_2 characterizing inelastic electron scattering, against the variable $\omega_W = (2M\nu + M_W\nu/q^2 + a^2)$. For this purpose a compilation of world data spanning the resonance and deep inelastic region and including photoproduction was used. It is shown that to the accuracy allowed by present experiments, ω_W is a good variable for all ν and q^2 values, including real photons. (auth)

23845 (ISS-69/39) SEMINAR AT THE PHYSICS LABORATORY DURING THE PERIOD JANUARY-APRIL 1969. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 6 Oct 1969. 43p. (In Italian). Dep. NTIS (U. S. Sales Only).

A synopsis of the lectures is presented. (auth)

23846 (JINR-E2-6235) CALCULATION OF THE πe-SCATTERING CROSS SECTION INVOLVING THE RADIATIVE CORRECTIONS AND REALISTIC EXPERIMENTAL CONDITIONS. Bardin, D. Yu.; Micelmacher, G. V.; Shumeiko, N. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 27p. Dep. NTIS (U.S. Sales Only).

A technique for calculation by the Monte Carlo method of the elastic πe-scattering cross section, to order a^3, which makes it possible to take account of the realistic experimental conditions, is suggested. Detailed calculations are performed for energy of the primary pion beam 50 GeV. There are involved in the calculations the radiative loss of the electrons within a target, resolution of apparatus, uncertainty in the pion energy and experimental selection criteria of the elastic events. (auth)

23847 (LNF-71/68) SIMPLE METHOD FOR COMPUTING ELECTRODYNAMIC PROCESSES OF HIGH ORDER. Parisi, G.; Zirilli, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 13 Oct 1971. 10p. Dep. NTIS (U. S. Sales Only).

A general method is proposed to evaluate Feynman graphs; this method avoids the calculation of very long traces. Using this technique the exact differential cross section for the contribution of two photons annihilation to the process $e^+e^- \rightarrow e^+e^-e^+e^-$ is written where we take care of the Fermi statistics for the final particles. Also the polarization effects on this cross section are computed. (auth)

23848 (NP-19218) DETERMINATION OF THE $M_{1+}^{3/2}$ AND $E_{1+}^{3/2}$ MULTIPOLE AMPLITUDES OF PION PHOTOPRODUCTION ON NUCLEONS IN THE $\Delta(1236)$ RESONANCE REGION. Note No. 324. Jurewicz, A. (Rome Univ. (Italy). Istituto di Fisica). 1 Jul 1971. 22p. Dep. NTIS (U. S. Sales Only).

The multipoles $M_{1+}^{3/2}$ and $E_{1+}^{3/2}$ were determined by solving a system of integral equations resulting from the fixed-angle dispersion relations. The solutions depend on one parameter—the cutoff in energy which is determined by fitting the calculated values to data. A discussion of various solutions is presented. (auth)

23849 CONSEQUENCES OF SU_3 INVARIANCE, ABSENCE OF EXOTIC RESONANCES AND DUALITY FOR THE PHOTOPRODUCTION OF PSEUDOSCALAR MESONS. Bender, I.; Linke, V.; Koerner, J. G.; Schmidt, M. G. (Univ., Heidelberg). Lett. Nuovo Cim.; 3: No. 11, 441-8(11 Mar 1972).

The general structure of photoproduction amplitudes resulting from SU(3) invariance, the absence of exotic baryon and meson states, duality, and factorization of the pole residues is examined. Relations between differential cross sections for pseudoscalar meson production are obtained. (L.B.S.)

23850 LOCAL ONE-PARTICLE APPROXIMATION OF COMMUTATORS OF CONSERVED CURRENTS. Dahmen, H. D. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.); Rothe, H. J.; Rothe, K. D. Nuovo Cim.; 8A: No. 2, 416-30(21 Mar 1972).

The constraints imposed by current conservation are studied within a local one-particle approximation scheme for the case of a commutator of two isovector currents. The model satisfies the current algebra relations and makes specific statements about the structure of Schwinger terms. With appropriate modifications the method allows an extension to a generalized Veneziano model which is discussed in a subsequent paper. (auth)

23851 INELASTIC ELECTRON-PROTON SCATTERING AT LARGE MOMENTUM TRANSFERS AND THE INELASTIC STRUCTURE FUNCTIONS OF THE PROTON. Miller, G. (Stanford Linear Accelerator Center, Calif.); Bloom, E. D.; Buschhorn, G.; (and others). Phys. Rev., D; 5: No. 3, 528-44(1 Feb 1972).

Differential cross sections for electrons scattered inelastically from hydrogen were measured at 18°, 26°, and 34°. The range of incident energy was 4.5 to 18 GeV, and the range of four-momentum transfer squared was 1.5 to 21 $(GeV/c)^2$. With the use of these data in conjunction with previously measured data at 6° and 10°, the contributions from the longitudinal and transverse components of the exchanged photon were separately determined. The values of the ratio of the photoabsorption cross sections σ_S/σ_T are found to lie in the range 0 to 0.5. The question of scaling $2M_pW_1$ and νW_2 as a function of ω is discussed, and scaling is verified for a large kinematic range. Also, a new scaling variable which reduces to ω in the Bjorken limit is introduced which extends the scaling region. The behavior of σ_T and σ_S is also discussed as a function of ν and q^2. Various weighted sum rules of νW_2 are evaluated. (auth)

23852 SPIN-DEPENDENT INELASTIC ELECTRON-NUCLEON SCATTERING. Carlson, C. E.; Tung, Wu-ki (Univ. of Chicago). Phys. Rev., D; 5: No. 3, 721-4(1 Feb 1972).

It is shown that the simultaneous measurement of the longitudinal- and transverse-polarization effects in deep-inelastic lepton-hadron scattering offers a practical way of determining the two spin-dependent structure functions. These functions furnish interesting information on the spin dependence of scattering amplitudes at high energies as well as provide the natural testing ground for theoretical models based on light-cone singularities, partons, etc. (auth)

23853 TESTS FOR THE INTERNAL QUANTUM NUMBERS OF PARTONS. Nachtmann, O. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 5: No. 3, 686-9(1 Feb 1972).

The restrictions for the structure functions of deep-inelastic electroproduction and neutrino-induced production following

from assigning partons to any representation of SU(2) × SU(2) × Y are derived. Apart from the general parton-model assumptions only isospin invariance and positivity are used. Comparison with experiment allows us to exclude all models which have only partons of spin $\frac{1}{2}$, isospin $\leq \frac{1}{2}$, and integral charge. (auth)

23854 NUCLEON FRAGMENTATION IN INELASTIC ELECTRON SCATTERING. Choudhury, S. Rai; Rajaraman, R. (Univ. of Delhi). Phys. Rev., D; 5: No. 3, 694-9(1 Feb 1972).

An analysis is presented of the double-inclusive reaction $e + p \rightarrow e + c +$ anything in the region where c is a fragment of the target proton. The two structure functions that describe this scattering are introduced and are related in the asymptotic and subasymptotic regions to measured hadronic cross sections and electroproduction structure functions. (auth)

23855 PROSPECTS FOR PRODUCING AND DETECTING A SPINLESS W BOSON IN HIGH-ENERGY NEUTRINO AND MUON EXPERIMENTS. Turner, M. S.; Barish, B. C. (California Inst. of Tech., Pasadena). Phys. Rev., D; 5: No. 3, 638-61 (1 Feb 1972).

The possible production of the hypothetical spin-zero W boson (W_0) recently proposed by T. D. Lee, either through the decay of a directly produced spin-one W(W_1) or by direct production in the reactions $\nu + Fe \rightarrow Fe + W_0 + \mu$ and $\mu + Fe \rightarrow Fe + W_0 + \nu$, is discussed. Theoretical cross sections and differential distributions are presented here for W_1 masses between 2 and 40 GeV/c^2 and W_0 masses between 2 and 8 GeV/c^2 for beam energies from 80 to 300 GeV. It is shown that assuming nonzero muon mass in the calculations for a neutrino beam, rather than zero muon mass as suggested by Lee, can increase the total theoretical cross section by up to a factor of 1000 if M_1 is greater than $4M_0$ or if the W_1's anomalous magnetic moment is near 1. In general, the production cross sections with incident neutrinos for W_0's are down from those for W_1's by a factor of 20–100, while the cross sections with incident muons are nearly equal. The effects of the W_1's anomalous magnetic moment, W_0 and W_1 mass, and incident energy upon cross sections and distributions are discussed for the coherent and incoherent cases. Possible signatures for detecting a W_0 either in the decay of a W_1 or in a q^2-ν plot in direct production are discussed. (auth)

23856 SEARCH FOR NEW VECTOR MESONS BY DIFFRACTIVE PHOTOPRODUCTION AT THE NATIONAL ACCELERATOR LABORATORY. Sanda, A. I. (National Accelerator Lab., Batavia, Ill.); Wijangco, A. Phys. Rev., D; 5: No. 3, 661-71 (1 Feb 1972).

If an as yet unobserved vector meson exists, it can be seen most easily by diffractive photoproduction on nuclei using a photon beam at the National Accelerator Laboratory (NAL). The problem of coherent production of such a particle on nuclei is considered taking into account the mixing between the ρ and the new vector meson to arbitrary order. The method used here can be generalized to describe coherent scattering of hadrons and nuclei. It will be shown that the interference effect reduces the production of the new vector meson considerably and that the A dependence of the production cross section plays an important role. (auth)

23857 ANALYSIS OF VECTOR-MESON-PHOTOPRODUCTION EXPERIMENTS IN THE $\rho-\omega$ INTERFERENCE REGION. Lemke, J. L.; Sachs, R. G. (Univ. of Chicago). Phys. Rev., D; 5: No. 3, 590-6(1 Feb 1972).

Vector-meson photoproduction on nuclei in the $\rho^0-\omega$ interference region was observed both by means of experiments detecting photoproduction of e^+e^- pairs and by means of experiments detecting photoproduction of $\pi^+\pi^-$ pairs. These two phenomena are closely related to each other and to the corresponding interference phenomenon in $e^+e^- \rightarrow \pi^+\pi^-$. It is shown how the data on all such phenomena can be expressed in terms of three model-independent complex parameters: ϵ, the intrinsic $\rho-\omega$ mixing parameter, r_ω, the ratio of ω-photon to ρ-photon coupling at an energy corresponding to the mass of the ω, and P_ω/P_ρ, the ratio of nuclear photoproduction amplitudes for ω and ρ. Existing data on the interference phenomena are combined with data on the ratios of ρ and ω production cross sections to determine these parameters. It is found that $|\epsilon| = 0.034 \pm 0.004$, $|r_\omega| \equiv \gamma_\rho/\gamma_\omega = 0.34 \pm 0.07$, and $|P_\rho/P_\omega| = 3.44 \pm 0.19$ is the most consistent representation of the data. Because present experiments have uncertainties at the 10% level, it turns out that only relative phases can be determined. If r_ω is assumed to be real, the most consistent representation yields $\arg\epsilon = 95° \pm 15°$ and $\arg(P_\omega/P_\rho) = 0° \pm 21°$. The former result is in agreement with the expectations from mixing theory. The latter is interpreted in terms of a simple vector-dominance model and is shown to agree with simple peripheralism, that is, equality of the ρ and ω forward scattering amplitudes. Because of disagreements in the data from different laboratories, there may be some doubt about the reality of r_ω. It appears that the phase of r_ω could be determined in a model-independent way by an electron-positron colliding-beam experiment on interference in $\pi^+\pi^-$ production at the 1% level. (auth)

23858 STRUCTURE OF THREE-DIMENSIONAL DISTRIBUTION OF ELECTRONS NEAR THE AXIS OF AN ELECTRON–PHOTON SHOWER. Guzhavin, V. V.; Ivanenko, I. P.; Potapova, L. N.; Roganova, T. M. (Moscow State Univ.). Yadern. Fiz.; 14: No. 6, 1219-26(Dec 1971). (In Russian).

The dependence of the structure of three-dimensional distribution function on various shower parameters is investigated. The accuracy of the calculation of the shower electron angular distribution functions is analyzed in terms of the axis approximation. The accuracy of measurements of the E_0 shower energy is estimated numerically by the axis approximation method. (auth)

23859 POSSIBILITY TO MEASURE ELECTROMAGNETIC FORM FACTORS OF π AND K MESONS IN HADRON COLLISIONS. Geshkenbein, B. V.; Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 6, 1227-36(Dec 1971). (In Russian).

Possibilities are discussed to measure the pion and kaon electromagnetic form factors in the lepton pair production reaction induced by the particle on nucleus: $\pi(K) + A \rightarrow \pi(K) + A + l^+ + l^-$. It is shown that investigating the reaction in a particular kinematical situation at the incident energy $\epsilon \gtrsim 40$ GeV one is able in principle to measure the meson form factor in the space-like region at the momentum transfer $-q^2 \sim 1(\text{GeV})^2$. The cross section that is to be measured for the form factor to be found amounts to 10^{-33} to 10^{-34} cm^2 (for Pb target). (auth)

23860 LARGE ANGLE PAIR PRODUCTION IN COLLIDING BEAM EXPERIMENTS. Baier, V. N.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 15: No. 1, 95-9(Jan 1972). (In Russian).

Large angle muon and pion pairs electroproduction cross section for the collisions of high energy electrons and positrons was calculated. The production of the intermediate resonance 0^+ and 2^+ states was considered in case of pion production. (auth)

23861 CALCULATION OF THE ELECTROMAGNETIC MASS DIFFERENCE OF PIONS IN CHIRAL DYNAMICS. Ivanov, A. N. (Leningrad Polytechnic Inst.). Yadern. Fiz.; 15: No. 1, 108-22 (Jan 1972). (In Russian).

The electromagnetic mass difference of charged and neutral pions is calculated with Lagrangian method. Lagrangian of a self-interacting pion field from a Weinberg class form a basis of the calculation. A regularization method is proposed which is suited for this class of Lagrangians. As a result the value $m_{\pi^+} - m_{\pi^0} = 4.40$ MeV consistent with the experimental value 4.60 MeV was obtained for the electromagnetic pion mass difference. (auth)

23862 ELECTROMAGNETIC PRODUCTION OF W-MESON PAIRS. Ter-Isaakyan, N. L.; Khoze, V. A. (Inst. of Physics, Erevan). Yadern. Fiz.; 15: No. 1, 87-94(Jan 1972). (In Russian).

The integral cross sections of the photon emission in annihilation of the e^+e^- pair into W-meson pair are obtained. The photoproduction of a W-meson pair on an electron is considered. Explicit expressions for cross sections are given for the case of anomalous magnetic moment of the W-meson $\gamma = 0$. For the cases of $\gamma = \pm 1$ the results are given in the asymptotic energy region. It is shown that at $\gamma = 0$ the asymptotic cross section of the process $\gamma + e^- \rightarrow e^- + W^+W^-$ may be obtained using the Weizzekker–Wilyams method. (auth)

23863 DEVELOPMENT OF ELECTRON–PHOTON CASCADES OF ULTRAHIGH ENERGY IN THE ATMOSPHERE. Krasil'nikov, D. D.; Kulakovskaya, V. P.; Nikol'skii, S. I. (Inst. of Cosmic Research and Aeronomy, Novosibirsk, USSR). Yadern. Fiz.; 15: No. 1, 81-6(Jan 1972). (In Russian).

The results of the calculation of a number of cascade electrons from primary γ-quanta with energy 10^{17} to 10^{21} eV are given at the two observation atmospheric levels taking into account Landau–Pomeranchuk effect. The distribution of the ionization energy lost by cascade up to the observational level is also obtained. (auth)

23864 TOTAL NEUTRON CROSS SECTIONS MAY NOT BE WHAT THEY SEEM TO BE. West, G. B. (Stanford Univ., Calif.). Phys. Lett.; 37B: No. 5, 509-12(27 Dec 1971).

The constraint that real particles be produced in the final state is shown to lead to a depletion in the apparent value of the asymptotic total neutron cross section as determined from deuteron scattering. For pion, kaon or photon scattering this depletion is ~5%. For electron scattering, the effect scales and has a shape which is quite similar to the experimental data. Its magnitude depends crucially on the high momentum components in the deuteron. (auth)

23865 COORDINATE SPACE STRUCTURE IN THE PARTON MODEL. Jaffe, R. L. (Stanford Univ., Calif.). Phys. Lett.; 37B: No. 5, 517-20(27 Dec 1971).

The relation between the parton model and light cone analyses for highly inelastic leptonic processes is studied. Results are displayed which follow from scaling laws in general, independently of specific parton model predictions. It is concluded that the assumptions of the light cone analysis of inelastic electron scattering are supported by the parton model. However, the parton model matrix element for massive muon pair production is not light-cone dominated, nor does it have the same light cone singularity as inelastic electron scattering. (auth)

23866 SCATTERING OF ELECTROMAGNETIC WAVES FROM A MOVING CYLINDRICAL ELECTRON BEAM. Hodjat, Farokh. Los Angeles; Univ. of California (1971). 135p. University Microfilms Order No. 72-2829.

Thesis.

A theoretical and experimental investigation of scattering of electromagnetic waves from a cylindrical electron beam is described. Particular emphasis was placed on the velocity dependent scattering which is significant at relativistic velocities. The theoretical problem has been solved with the aid of Maxwell's equations and the Lorentz transformation. This transformation results in a simpler boundary value problem. Scattering from an infinite electron beam inside a dielectric cylinder was considered. This case corresponds to that of the beam surrounded by a glass envelope. The problems of an electron beam with nonuniform charge density and an electron beam in finite magnetic field were also discussed. Computer programs for solving for the coefficient of the scattered waves were written. An experimental setup was designed to provide a vertical polarized plane wave normally incident on an electron beam. The setup consists of a transmitter and parallel plane wave-guiding system, an electron gun assembly, and a receiving antenna circuit for measuring scattering. The experimental results were achieved by using a very high intensity incident wave with a frequency comparable with the plasma frequency. The scattered field was measured for a dielectric cylinder, a hollow dielectric cylinder and an electron beam surrounded by a dielectric cylinder. For the last case, both the z-directed scattered electric field and the cross-polarized scattered magnetic field were obtained. These results compared well with those predicted by the theory. (TSS) (Diss. Abstr. Int., B)

23867 TIME EVOLVING THEORY OF THE MECHANICS OF SINGLE PARTICLES AND SINGLE PHOTONS. Cawley, Robert G. (Naval Ordnance Lab., Silver Spring, Md.). Int. J. Theor. Phys.; 5: No. 2, 101-22(1972).

Space–time ensemble methods are introduced to formulate definitions of single particles and single photons as local abstractions of constant processes. The general form of the corresponding Stueckelberg Lagrangian for Riemannian and Newtonian space–times is found and a physical interpretation for the worldline parameter is supplied. The corresponding mechanical theories over the extended configuration space and the extended phase space are developed. It is supposed that the background can be represented by an "external field" and several general examples are studied. Certain phenomenological forms do not describe particles, other do not seem to describe theories in which the representation of the gackground is process independent (Riemannian case). At the canonical level the elimination of second-class constraints associated with null processes generates restrictions on the domain of definition of photon coordinates which correspond to the absence of zero energies. The requirement that the canonical process–anti-process classification shall exist leads to a factorization condition on the extended phase space which is satisfied for all the cases studied in which the configuration formalisms entail no difficulties, except one, which is the "minimally" coupled external vector field case over Riemannian space–times. The observational theoretical significance of the results is discussed. (auth)

23868 NONLOCAL THEORY OF SINGLE PION PHOTOPRODUCTION Tang, L. H. (Univ. of Detroit). Int. J. Theor. Phys.; 5: No. 1, 55-70(1972).

A nonlocal interaction theory is formulated for photoproduction processes by introducing a form function. An effective nonlocal, Lorentz invariant and gauge invariant Lagrangian density for the four-field interaction that gives rise to a production amplitude is constructed. The general structure of the form function is investigated by using some restrictions of the form function. For low energy π^0 photoproduction an explicit form of the Fourier component of the form function is obtained. The physical model of the formalism is to assume, similar to the strong absorption model, that the system in intermediate states is confined in a finite domain of space Ω_0. For π^0 production the linear dimension of this domain is found to be $\Omega_0 = 3.88$ F. It is important to observe that the extent of electromagnetic distribution in a nucleon is also nearly the size of Ω_0. This is believed to be the reason that in low energy pion photoproduction the effects of electromagnetic structure of a nucleon are irrelevant. The unpolarized differential and total cross sections are calculated for π^0 production in helicity representation and the predictions are found to be in good agreement with experiments. (auth)

23869 ORDER OF MAGNITUDE OF 8th ORDER CORRECTIONS TO THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. Lautrup, B. (CERN, Geneva). Phys. Lett.; 38B: No. 6, 408-10(20 Mar 1972).

It is shown that the 8th order contribution to the muon anomaly can be as large as $100-200 \times (\alpha/\pi)^4$. (auth)

23870 RADIATIVE CORRECTIONS TO COINCIDENCE EXPERIMENTS IN HIGH ENERGY ELECTRON–ELECTRON AND POSITRON-ELECTRON SCATTERING. Redhead, M. L. G. (University Coll., London). J. Phys., A (London); 5: No. 3, 431-43(Mar 1972)

The theory of coincidence experiments in electron–electron and positron–electron scattering is considered where the energies of both the scattered and recoil particles are defined to lie within prescribed narrow limits of their values for elastic scattering. Approximate formulas valid at very high energies, where nonlogarithmic terms may be neglected, are worked out. Both the clashing beam and the stationary target type of experiment are discussed, and in the latter case the effect of finite angular resolution in the detector system of the scattered particle is investigated. Numerical results are given for beam energies of 1000 mc^2. The resulting radiative corrections are much larger than in those types of experiment previously considered by Tsai (Phys. Rev. 120: 269(1960)), and this provides the possibility of a more significant experimental test of the theory. (auth)

23871 CHERENKOV RADIATION NEAR A DIELECTRIC BOUNDARY. Thomas, R. B. Jr. (Lockheed Research Lab., Palo Alto, Calif.). Phys. Rev., A; 5: No. 3, 1131-7(Mar 1972).

The influence of Čerenkov-radiation loss on the emission spectrum and motion of an electron passing near the surface of a semi-infinite plane dielectric is treated on the basis of several simplifying assumptions. Equations of motion are obtained and solved for electron velocities just above radiation threshold in a region of anomalous dispersion. Expressions are found for the spatial and temporal dependence of the emission spectrum. A determination is made of the electron's total angular deflection which may exceed 10^{-2} deg; this result is shown to be in reasonable agreement with an estimate based on measured emission levels. Possible corrections resulting from induced bremsstrahlung and inelastic interactions with the dielectric are discussed. (auth)

23872 PROCESS $\pi^\pm \to \pi^0\pi^\pm$ IN COULOMB FIELD AND ANOMALOUS DIVERGENCE OF NEUTRAL AXIAL-VECTOR CURRENT. Terent'ev, M. V. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 38B: No. 6, 419-22(20 Mar 1972).

The amplitude of the process $\gamma\pi \to \pi\pi$ is expressed through the π^0-decay constant. The obtained relation is fulfilled if Adler's anomalous condition for the divergence of axial-vector current has taken place. So the relation may be used for verifying the hypothesis of Adler. (auth)

23873 VALIDITY OF SCALING RELATIONS BETWEEN NUCLEON FORM FACTORS. Singh, Virendra (Rockefeller Univ., New York). Phys. Rev. Lett.; 28: No. 13, 859-62(27 Mar 1972).

It is proved, within the framework of analytic S-matrix theory and the physical mass spectrum, that the following scaling relations cannot be rigorously true for all t: (i) $G_M^V(t) \propto G_E^V(t)$, (ii) $G_M^V(t) = R_1(t)G_E^V(t) + R_2(t)$, where $R_{1,2}(t)$ are rational functions of t, (iii) $F_\pi(t) \propto G_E^V(t)$, and (iv) $F_\pi(t) \propto G_M^V(t)$. (auth)

23874 NONLOCAL DIFFERENTIAL CROSS SECTION FOR KNOCKON ELECTRONS FROM MUON–ELECTRON INTERACTION. Ion, Ion X. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: No. 5, 583-8(1970). (In Rumanian).

With a Drell's nonlocal photon propagator, the differential cross section for the muon–electron interaction is analyzed. The nonlocal to local cross-section dependence of the cutoff parameter Λ and incoming muon at fixed angle and knock-on electron energy is shown. (2 figures) (auth)

23875 VECTOR MESONS. Gabathuler, E. (Daresbury Nuclear Physics Lab., Eng.). J. Phys., A (London); 5: No. 3, 327-47(Mar 1972).

Vector mesons with the same quantum numbers as the photon

are expected to play an important role in electromagnetic interactions. The study of the electromagnetic decays of these mesons and their production by photons has provided related information which can be used to understand this interaction. The experimental information which is currently available is presented and compared with theoretical ideas. (auth)

23876 MOTION OF A SPINLESS PARTICLE THROUGH A MEDIUM IN THE FIELD OF AN ELECTROMAGNETIC WAVE. Dement'ev, A. S.; Kul'kin, A. G.; Pablenko, Yu. G. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 490-2(Jul-Aug 1971). (In Russian).

The interaction of a particle with a powerful electromagnetic wave leads to nonlinear effects, and an investigation of such effects may yield new information on the structure of matter and on the influence of the medium as well as the wave on the character of particle interaction. The development was begun with the classical motion of a charged particle in an isotropic transparent medium in the field of an intense monochromatic electromagnetic wave. The refractive index of the medium thus depends on the frequency and intensity of the wave. It is shown that the motion of the particle acquires real meaning in the system in which the wave is propagated along the z axis while the particle is at rest on the plane xy. (K.S.W.)

23877 INDUCED EMISSION IN A VARIABLE MAGNETIC FIELD. Kul'kin, A. G.; Loskutov, Yu. M.; Pavlenko, Yu. G. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 424-8 (Jul-Aug 1971). (In Russian).

During parametric action of a variable magnetic field on a system of nonrelativistic particles under certain fixed conditions, induced radiation prevails over absorption. (tr-auth)

23878 ENERGY LOSSES OF CHARGED PARTICLES IN A GYROTROPIC MEDIUM. Kukanov, A. B.; Orisa, B. D. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 363-9(Jul-Aug 1971). (In Russian).

A general expression for polarization vectors in an electromagnetic field was found based on a solution of Frenell's equation for a gyrotropic medium. A connection between two known approaches to the solution of the problem of charged particle emission in the stated medium was established. An application of the generalized formulas obtained was made to the case of radiation of spirally moving charged particles in a gyrotropic medium. (tr-auth)

23879 BREMSSTRAHLUNG RATE AND SPECTRA FROM A HOT GAS (Z = 1). Maxon, Stephen (Univ. of California, Livermore). Phys. Rev., A; 5: No. 4, 1630-3(Apr 1972).

An interpolation between the quadrupole and extreme relativistic electron–electron bremsstrahlung contribution to the emission rate and spectra from a Maxwell–Boltzmann electron gas is carried out. These results are then added to the "exact" electron–ion results already in the literature to give the total emission for the temperature region 1 keV $\leq kT_e \lesssim$ 0.3 MeV. It is found that quadrupole corrections are sufficient until the temperatures reach $kT_e \simeq$ 100 keV. At higher temperatures all multipoles must be included in order to describe the emission accurately. (auth)

23880 NONLINEAR BREMSSTRAHLUNG. Osborn, R. K. (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 5: No. 4, 1660-2(Apr 1972).

A computation of the probability per unit path per photon for an arbitrary number of photons to be emitted or absorbed by an electron passing through the field of an ion is presented. The results provide a qualitative estimate of the conditions for the onset of nonlinear processes. (auth)

Weak

Refer also to abstract 23794.

23881 (LNF–71/72) MANIFESTLY CONFORMAL COVARIANT OPERATOR PRODUCT EXPANSION. Ferrara, S.; Grillo, A. F.; Gatto, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy), Laboratori Nazionali di Frascati). 8 Nov 1972. 10p. Dep. NTIS (U. S. Sales Only).

A manifestly covariant method, which takes advantage of the isomorphism between the conformal algebra and the orthogonal algebra 0(4,2) and makes use of a six-dimensional pseudoeuclidean coordinate space, is further developed to derive a manifestly conformal covariant operator product expansion valid at all values of x^2. It is emphasized that whereas conformal invariance as well as scale invariance of the complete theory may in some form hold near the light cone, the possibility is excluded that the complete theory is fully conformal and scale invariant. But the implications of exact conformal invariance, not restricted to the light cone alone, might still prove useful in discussing the properties of the skeleton theory and fundamental problems such as that of canonical dimensions. (J.F.P.)

23882 (NP–19220) ANGULAR CORRELATIONS OF THE DECAY PRODUCTS OF TWO HEAVY LEPTONS. Note No. 327. Parisi, G.; Zirilli, F. (Rome Univ. (Italy). Istituto di Fisica). 12 Jul 1971. 4p. Dep. NTIS (U. S. Sales Only).

The cross section for heavy lepton pair production in $e^+ + e^-$ interactions in colliding beams is found. Since one-prong decays of the heavy lepton are dominant, the main process in the colliding beams is $e^+ + e^- \rightarrow$ 2 charged particles + neutrals. The angular correlations for the charged particles produced are found, as are the asymmetry parameters of the decay of the heavy leptons. The asymmetry parameters are given for $\pi + \nu$, $K + \nu$, $\mu + \nu + \overline{\nu}$, and $e + \nu + \overline{\nu}$ emission in these decays. (J.F.P.)

23883 K_{l3} DIVERGENCE FORM FACTOR, ($K\pi$) SCATTERING AND PADE APPROXIMATIONS. Schuelke, L.; Wambach, U. M. (Ruhr Univ., Bochum, Ger.). Lett. Nuovo Cim.; 3: No. 11, 433-40(11 Mar 1972).

A relation between the imaginary part of the K_{l3} form factor and its absolute square is obtained by using a quasi-single-particle state κ with variable mass. Proceeding with the assumption that the form factor can be written as a pole plus a regular part, which can be expanded in terms of the residue of this pole, a nontrivial Pade approximant for the form factor is calculated. The results obtained for $\xi(0)$ and λ_- and for $K\pi$ phase shifts using this form factor with a definite choice of one parameter are found to be consistent with the experimental data. (L.B.S.)

23884 CONFIGURATION MIXING AND RENORMALIZATION IN CABIBBO'S THEORY. Santhanam, T. S. (International Center for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 11, 454-6(11 Mar 1972).

A model was previously proposed where the physical baryons are mixtures of the lowest-lying representations [8] and [10] of SU(3). The model is applied to the leptonic decay of hyperons, using the standard assumptions of Cabibbo theory. The small difference in the vector coupling constant in the beta decay is explained. (L.B.S.)

23885 I. COVARIANT TIME-ORDERED PRODUCTS OF n CURRENTS. II. K_{l3} FORM FACTORS WITH A MASSLESS PION. Yang, Tsih Chiang. Rochester, N. Y.; Univ. of Rochester (1971). 208p. University Microfilms Order No. 72-784.

Thesis.

The purpose of Part I is to show the existence of covariant time-ordered products of arbitrary number of (conserved or unconserved) currents. A brief introduction to current algebra is given, pointing out through examples of application of current algebra where the problem of covariant time-ordered product and the Schwinger term come in. The Schwinger term, the "seagull" term, and the time-ordered products are studied. The assumptions used are stated, and the physical implication of the assumptions are discussed. The construction of the covariant time-ordered product is studied and the covariance of the time-ordered product so defined is explicitly shown. A generalization of this approach, a different approach to study the covariant time-ordered product and finally the possible consequences of the failure of Feynman's conjecture are discussed. In the second part, the problem of K_{l3} ($K \rightarrow \pi l \nu$) decay is investigated. The K_{l3} form factors were studied before using soft-pion technique and hard-pion method. A massless-pion method is introduced. This method is first studied in a strangeness-conserving process, e.g., $A_1\rho\pi$ system, and the same result as obtained by using dispersion approach or usual hard-pion method is found. The various assumptions used in different methods are discussed in detail. The massless pion method provides a general framework for studying the form factors and leads to a new soft-pion relation for K_{l3} form factors (a strangeness-changing process). Various theorems on K_{l3} form factors and the hard pion method are reviewed. The new soft-pion relation, in addition to the famous soft-pion theorem is derived. Using the soft-pion results as subtraction constants, once-subtracted dispersion relations are used for K_{l3} form factors. The results are then discussed and in particular compared with the results of other calculations. (TSS) (Diss. Abstr. Int., B)

23886 PRESENCE OF ONE-FIREBALL-LIKE BEHAVIOR IN MULTIPLE PARTICLE PRODUCTIONS BY MUONS. Kitamura, T.; Okabe, H.; Wada, T. (Osaka City Univ.). Nuovo Cim.; 8A: No. 2, 372-80(21 Mar 1972).

Forty-nine selected events from 133 muon-nucleon interactions in the energy range from 10 to 100 GeV were obtained by the underground group of the Osaka City University by means of large cloud chambers; the emulsion group of the University has also ob-

served more than 200 events of pion production in nuclear emulsion bombarded with the 5 GeV/c muon beam from the Brookhaven accelerator. An attempt is made to show that a large part of the cloud chamber data with more than two particles is consistent with the predictions of the one-fireball model in which a fireball may be emitted in the center-of-mass system at a large angle from the incident-muon axis, whereas the emulsion data at 5 GeV/c are dominated by contributions from isobars. (auth)

23887 GREEN'S FUNCTIONS OF CURRENTS AND DEEP INELASTIC LEPTON–NUCLEON SCATTERING. Etim, E. (Univ., Naples). Lett. Nuovo Cim.; 3: No. 10, 407-10(4 Mar 1972).

The basic ideas underlying a relation between scaling of many-body Green functions near the characteristic critical points and the observed scaling in hadron dynamics are pointed out. Within this framework, current bilinears in inclusive lepton-nucleon scattering are averaged over a grand canonical ensemble representative of the nucleon as a composite structure. The weak structure functions of the neutron are found to be proportional to those of the proton. The total cross sections for neutrino–nucleon scattering are computed, making use of CVC and the equality of vector and axial-vector contributions to the structure functions. (L.B.S.)

23888 DECAY $K_L \to \mu^+\mu^-$ AND THE POSSIBLE EXISTENCE OF A NEW LOW-MASS FERMION. Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay. Technische Hochschule, Aachen). Phys. Rev., D; 5: No. 3, 744-7(1 Feb 1972).

An attempt to made to understand the low upper limit on $\Gamma(K_L \to \mu^+\mu^-)/\Gamma(K_L \to \gamma\gamma)$ within the framework of CP conservation. The existence is assumed of a pair of new particles, λ and $\bar{\lambda}$ of spin ½, zero charge, and small mass, which couple to leptons as well as hadrons in a symmetrical manner. A suppression of the decay $K_L \to \mu^+\mu^-$ is achieved through interference of the absorptive parts arising from the $\gamma\gamma$ and $\lambda\bar{\lambda}$ intermediate states. Implications of the hypothesis for electromagnetic and weak processes are explored. (auth)

23889 STUDY OF THE DECAYS $K \to \mu\nu e^+e^-$ AND $K \to e\nu\mu^+\mu^-$. Krishna, S.; Mani, H. S. (Indian Inst. of Tech., Kanpur). Phys. Rev., D; 5: No. 3, 678-81(1 Feb 1972).

The decays $K \to \mu\nu e^+e^-$ and $K \to e\nu\mu^+\mu^-$ were discussed in a hard-meson model. The structure-dependent effects can be seen in the $K \to \mu\nu e^+e^-$ mode only at large values of the mass of the virtual photon. However, in $K \to e\nu\mu^+\mu^-$ decay the structure-dependent terms predominate, even though the branching ratio is small. (auth)

23890 LOWER BOUND ON λ_+ IN K_{13} DECAY. Acharya, R. (Univ. of Texas, Austin). Phys. Rev., D; 5: No. 3, 768-9(1 Feb 1972).

A lower bound on λ_+ is derived under the assumption that the chiral SU(2) × SU(2)-breaking correction term to the soft-pion theorem in K_{13} decay is positive. Earlier estimates of phenomenological parameters by Okubo are adopted and $\lambda_+ \gtrsim 0.05$ is obtained. (auth)

23891 ISOVECTOR SPECTRAL FUNCTION AND K_{13}^+ DECAYS. Langacker, Paul (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 3, 710-14(1 Feb 1972).

An inequality relating the parameter λ_+ of K_{13} decays to the spectral function of the isovector electromagnetic current is derived, assuming only Weinberg's first spectral-function sum rule. It is shown that a large value for λ_+ (e.g., $\lambda_+ = 0.045$) is not compatible with ρ saturation of the isovector spectral function. Since the principal tests of the sum rule have relied on the additional assumption that such resonance saturations are possible, some doubt is cast on the validity, or at least on the previous applications, of the sum rule. Implications for the Weinberg mass relations, c-number Schwinger terms, and the e^+e^--annihilation cross section are discussed. (auth)

23892 TIME REVERSAL AND β DECAY: A GENERALIZATION OF THE KIM–PRIMAKOFF THEOREM. Rosen, S. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; No. 3, 760-2 (1 Feb 1972).

Kim and Primakoff have shown that certain T-violating currents cannot contribute to neutron β decay because of their properties under charge symmetry. Here it is shown that the same currents cannot contribute to strangeness-conserving β-decay transitions within any isomultiplet. The result is extended to strangeness-violating decays by means of V spin. (auth)

23893 LOW-ENERGY AXIAL-VECTOR FORM FACTORS FOR K_{e4} DECAY BASED ON BROKEN CHIRAL SYMMETRY. Wienke, B. R.; Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 5: No. 3, 725-33(1 Feb 1972).

An analysis is made of K_{e4} decay, particularly the process $K^+ \to \pi^+\pi^-e^+\nu$, using the techniques of current algebra and the $(3^*,3) \oplus (3,3^*)$-breaking model. The axial-vector form factors with explicit dependence on the chiral-symmetry parameters are obtained at the points $k^2 = p^2 = q^2 = 0$ and $k^2 = m_K^2$, $p^2 = q^2 = 0$ and predictions compared with experimental rates and distributions. Discussion and comparison of the results with other recent analyses are also given. In particular, it is found that $f_K = f_\pi$ and $f_k = 0$ gives good over-all agreement with the experimental rate, the fitted form factors, and the experimental distributions although small breakings in f_K/f_π and somewhat larger breakings in f_k/f_π are not ruled out. (auth)

23894 ANGULAR AND ENERGY DISTRIBUTIONS OF NEGATIVE MUONS IN LEPTON PAIR PRODUCTION INDUCED BY MUON NEUTRINO. Asratyan, A. E.; Tikhomirov, A. M.; Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 6, 1245-6(Dec 1971). (In Russian).

Calculations of angular and energy distributions of μ^--mesons produced in reactions $\nu_\mu + Z \to Z + \mu^- + e^+ + \nu_e$ and $\nu_\mu + Z \to Z + \mu^- + \mu^+ + \nu_\mu$ for the neutrino energies up to 50 GeV are presented. (auth)

23895 THREE-PION STATES IN THE $K_L \to \mu^+\mu^-$ PUZZLE. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.); Farrar, Glennys R.; Treiman, S. B. Phys. Rev., D; 5: No. 3, 770-2(1 Feb 1972).

Contributions to the absorptive $K_L \to 2\mu$ amplitude coming from intermediate 3π states are estimated on the basis of recent soft-pion results for the process $3\pi \to 2\gamma$. These contributions turn out to be far too small, by 4 orders of magnitude, to resolve the $K_L \to 2\mu$ puzzle. (auth)

23896 VIOLATION OF THE $|\Delta T| = ½$ RULE IN CHIRAL DYNAMICS. Kapustnikov, A. A. (Dnepropetrovsk State Univ., USSR). Yadern. Fiz.; 14: No. 6, 1260-4(Dec 1971). (In Russian).

Nonleptonic weak interactions violating the $|\Delta T| = ½$ rule are considered on the basis of the effective Lagrangian method. It is shown that taking the Lagrangian without derivatives one gets predictions on deviations from the $|\Delta T| = ½$ rule in the $K \to 2\pi$, 3π decays that are in agreement with the experiment provided the mass differences in $\pi^\pm - \pi^0$ and $K^\pm - K^0$ are taken into account. (auth)

23897 TERMS OF $(Gs)^3$ ORDER IN THE AMPLITUDES OF WEAK LEPTONIC PROCESSES. Dolgov, A. D.; Zakharov, V. I.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 6, 1247-59(Dec 1971). (In Russian).

Dispersion relations are applied to weak leptonic processes at high energies. The terms of $(Gs)^2$ order in the amplitude of annihilation $e^+e^- \to \nu\bar{\nu}$ and the terms of $(Gs)^3$ order in the amplitudes of weak elastic scattering $e^+e^- \to e^+e^-$ and of the process $e^+e^- \to \mu^+\mu^-$ were considered. If the fast rise of weak cross sections which holds at small energies stops at energies of order of unitary limit then the terms under consideration could be small even at $Gs \sim 1$. (auth)

23898 ISOSPIN CONSTRAINTS ON SEMI-INCLUSIVE NEUTRINO REACTIONS AND THEIR HADRONIC ANALOGS. Llewellyn-Smith C. H. (Stanford Linear Accelerator Center, Calif.); Pais, A. Phys. Rev. Lett.; 28: No. 13, 865-9(27 Mar 1972).

The processes $\nu(\bar{\nu})$ + target → hadron + $\mu(\bar{\mu})$ + anything are considered in the cases where the hadron selected has $I = ½$ or 1. Inequalities are given which follow from the conventional assignment of isospin to the weak current (for $\Delta S = 0,1$) and the charge-symmetry conditions for the $\Delta S = 0$ current. νd and $\bar{\nu}d$ processes with $\Delta S = 1$ yield an equality if the hadron selected has $I = 1$. The hadronic analogs of these reactions are also discussed; bounds are given for $\pi^- + p \to$ hadron + anything, which are stronger than those previously reported. (auth)

23899 COMMENTS ON SOME FOUR-BODY K_L^0-DECAYS. Bace, M.; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Lett.; 38B: No. 6, 429-30(20 Mar 1972).

It is pointed out that the (yet unmeasured) decay modes $K_{L,S}^0 \to \pi^+\pi^0e^-\nu$ can be used to distinguish between the p-wave $\pi^+\pi^-$ scattering parameters of $K^+ \to \pi^+\pi^-e^+\nu$ decay. Also, the possibility of measuring CP-violation in $K_L^0 \to e^+e^-e^+e^-$ decay is discussed. (auth)

23900 CP NON-INVARIANCE AND THE $K_S \to \mu^+\mu^-$ DECAY RATE. Dass, G. V. (CERN, Geneva); Wolfenstein, L. Phys. Lett.; 38B: No. 6, 435-8(20 Mar 1972).

Christ and Lee suggested CP noninvariance as an explanation of the low experimental $K_L \to \mu^+\mu^-$ decay rate. Hamiltonian realizations of this mechanism, and the lower bounds on the $K_S \to \mu^+\mu^-$ decay rate implied by them are discussed. The lower

bound on the $K_S \rightarrow \mu^+\mu^-$ branching ratio varies in these models from 10×10^{-7} (for the most economical model) to 2×10^{-7}. (auth)

23901 CONSEQUENCES OF SCALING FOR HIGH ENERGY COSMIC RAYS. Wdowczyk, J. (Inst. of Nuclear Research, Lodz, Poland); Wolfendale, A. W. Nature (London) Phys. Sci.; 236: No. 63, 29-30(13 Mar 1972).

It has been suggested that the energy spectrum of particles emitted in high energy nucleon-nucleon collisions may "scale" with increasing energy in a rather simple way. This suggestion is based on the parton model of the nucleon, some of the predictions of which appear to fit accelerator and cosmic ray data. Some consequences of particular relevance to the application of the scaling model to high energy cosmic ray phenomena are discussed, together with comparisons with other models. Application is made to both sea-level and underground muons. The many different types of extensive air shower measurements, such as longitudinal electron distribution, muon and electron fluctuations, radio pulses, nucleonic spectra, etc.; should all be analyzed to see to what extent the scaling hypothesis affords a consistent interpretation. There is a need for detailed calculations with the scaling hypothesis to investigate the interesting astrophysical possibility that the effective mass of cosmic ray primaries increases with energy. (UK)

Strong (General)

23902 (JINR-E1-6263) POSSIBLE EXISTENCE OF HADRON ISOMERS. Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 6p. Dep. NTIS (U. S. Sales Only).

The idea is expressed that hadron isomers might exist. These would be hadrons with low excitations, high spin values, decaying with long mean lives (because of the centrifugal barrier). The possibility of detecting these particles is discussed. It is shown that the existence of hadron isomers would not contradict any known experimental facts. (auth)

23903 SPECTROSCOPY FOR HADRONS. Mac Gregor, M. H. (Univ. of California, Livermore). Nuovo Cim.; 8A: No. 2, 235-97(21 Mar 1972).

A data compilation is given of 140 meson and baryon resonances. Using the principles of nuclear physics as a guide, a set of meson and baryon excitation levels (analogous to vibrational levels) and corresponding rotational bands are deduced. The excitations occur as "excitation towers" built on a set of fundamental ground states. The excitations follow accurate 70 MeV and 210 MeV interval relationships. All binding energies are small ((1 to 3)%). The rotational bands have cutoffs imposed by the requirement that the periphery should not exceed the velocity of light. A hadron basis set is defined consisting of the spinless mass quanta $1 \equiv 70$ MeV and $3 \equiv 210$ MeV and the fermion spinor $S \equiv 327$ MeV, $J = \frac{1}{2}\hbar$. One and 3 differ in their isotopic-spin rules. By forming combinations of 1, 3 and S (and their antistates), the masses, spins, widths and principal decay modes of the 140 meson and baryon resonances are accurately produced. A dozen of these resonances were first predicted by this model and then, subsequently, verified in the published data. The model is extended by giving 1, 3 and S specific geometries and (integral) charge states and, thereby, reproduce the measured magnetic moments and charge splittings. When this is done, the mass of the muon is shown as related to the hadronic basis set. The strangeness quantum number fits naturally into the isotopic-spin formalism. The model is used to unravel a number of experimental puzzles, including the splitting in the A_2-meson, the occurrence of a spin-1 ABC resonance and the existence of (M, η', δ^-) and (H, π_N, φ) as single I = 1 meson resonances. The model is also helpful in accounting for some striking relationships in meson lifetimes. A dynamical method for testing particle symmetries is proposed, and implications for other branches of physics are briefly discussed. Important new experimental results and recent theoretical improvements are given. (auth)

23904 HOW ACCURATE ARE QUARK-MODEL DOUBLE-SCATTERING RELATIONS? Barnhill III, Maurice V. (Univ. of Delaware, Newark). Phys. Rev., D; 5: No. 3, 733-43(1 Feb 1972).

The quark-model multiple-scattering relations were rederived using the formalism of Goldberger and Watson instead of the Glauber formalism used by all authors previously. It is shown that deep binding of the quarks need not invalidate the use of the impulse approximation and that definite limits may be placed on the angular range of validity of the formulas. For an incident momentum of 5 GeV/c in the center-of-momentum frame, the conventional multiple-scattering formulas are estimated to be reasonably accurate for a momentum transfer squared less than 3 $(\text{GeV}/c)^2$. (auth)

23905 ELECTROMAGNETIC CONTRIBUTIONS TO INELASTIC HADRON PROCESSES. Low, F. E.; Treiman, S. B. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 5: No. 3, 756-60(1 Feb 1972).

Evidence obtained from inelastic electron scattering experiments supports the possibility that electromagnetic effects may become significant in hadron reactions for production of particles with sufficiently high transverse momentum. Estimates of the electromagnetic contributions are given, along with much cruder estimates of the crossover transverse momentum where these effects may become competitive with the purely strong-interaction contributions. (auth)

23906 INCLUSIVE EXPERIMENTS, EXCHANGE DEGENERACY, AND REGGEON TOTAL CROSS SECTIONS. Finkelstein, J.; Rajaraman, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 5: No. 3, 672-8(1 Feb 1972).

Some results concerning the triple-Regge domain of inclusive distributions are presented. It is shown that exchange degeneracy requires the equality of the proton-Reggeized-ρ and the proton-Reggeized-A_2 total cross sections, and this cross section is then extracted from data on the reaction $K^+p \rightarrow K^0$ + anything. This cross section turns out to be of the same order as physical meson-proton cross sections for a range of Reggeon mass. Relationships are derived between different inclusive distributions, such as $pp \rightarrow pX$, $K^+p \rightarrow K^+X$, and $K^+p \rightarrow K^0X$, and get good agreement with data. It is suggested that other inclusive distributions, such as $pp \rightarrow \pi^+X$, may be calculated using as input only our knowledge of two-body reactions. (auth)

23907 ω UNIVERSALITY REVISITED. Lipkin, H. J. (Argonne National Lab., Ill. National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 5: No. 3, 776-8(1 Feb 1972).

The ω universality relation is shown to agree with experiment also at Serpukhov energies up to 50 GeV, even though other regularities found at lower energies do not persist and a simple pole interpretation of the data would require different intercepts for the ρ and ω trajectories. Applications of the ω universality relation to inclusive reactions are suggested. (auth)

23908 EMPIRICAL TEST FOR COMPOSITE HADRONS. Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., D; 5: No. 3, 610-23(1 Feb 1972).

An empirical test to distinguish hadrons which are composites in the low-threshold channels from those which can be understood only from a more global point of view is described. This test is based on the existence of a pole in the K matrix in the latter case. Thus, the absence of a K pole signals a composite hadron. The test is applicable to hadrons coupled to S-wave two-body channels only. The properties of the K pole are analyzed using a field-theoretic model, and the pole and the residues are related to the wave-function renormalization constant of the hadron. Coupling-constant sum rules which are connected to the test for compositeness are also constructed. Applications to $\Lambda(1405)$ and other hadrons are described. (auth)

23909 CENTRIFUGAL-BARRIER EFFECTS IN RESONANCE PARTIAL DECAY WIDTHS, SHAPES, AND PRODUCTION AMPLITUDES. von Hippel, Frank (Argonne National Lab., Ill.); Quigg, C. Phys. Rev., D; 5: No. 3, 624-38(1 Feb 1972).

(1) A review is made of the experimental status of identifiable centrifugal-barrier effects in: (i) shapes of resonances, (ii) accounting for deviations in SU(2) and SU(3) predictions for ratios between partial decay widths, and (iii) accounting for the dependence on spin of the elastic widths of resonances lying on the same Regge trajectory. (2) A contour plot is presented, from which the "kinematic partial width" (centrifugal-barrier penetration factor times two-body phase space) of any resonance into any decay channel may be obtained immediately, given the orbital angular momentum, semiclassical impact parameter, and an assumed strong-interaction radius. Using this technique as an example, the kinematically preferred decays of the high-spin mesons on the leading meson trajectory (assumed linear) are displayed. (3) An approximate lower bound on the strong-interaction radius is obtained on the basis of general considerations. (4) It is shown that, for high-spin resonances, it can be expected that the mass enhancements in different decay channels associated with these resonances may be shifted by a half-width or so with respect to each other, because of different centrifugal-barrier effects in the different channels. (5) It is also shown that production cross sections of high-spin particles on leading linear trajectories by either formation or peripheral processes will be substantially suppressed by centrifugal-barrier effects. (6) Finally, it is observed that the production cross sections and decay widths of mesons on the leading trajectory of the Veneziano model can be understood almost entirely on the basis of kinematical con-

siderations if the radius of the region in which the decay particles interact strongly grows linearly with the mass of the decaying resonance. (auth)

23910 ASPECTS OF DIFFRACTION DISSOCIATION. Satz, H.; Schilling, K. (Univ. of Helsinki). pp 185-224 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

A number of general features of diffraction and diffraction dissociation, such as energy dependence, relation to elastic diffraction, diffraction dissociation as t-channel exchange, and dissociation mass analysis, are reviewed. The discussion of spin and helicity in diffraction dissociation deals with the recent experimental and theoretical activities concerned with the spin structure in diffraction scattering and diffraction production. (Finland)

23911 LONGITUDINAL PHASE SPACE ANALYSIS AND RELATED QUESTIONS. Van Hove, L. (European Organization for Nuclear Research, Geneva). pp 227-74 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

The analysis of multiparticle hadron reactions at high energy in terms of longitudinal variables is reviewed. Priority is given to the task of acquiring a comprehensive and detailed knowledge of the experimental facts. Little attention is paid to the various currently popular models. (Finland)

23912 MULTIPERIPHERAL BOOTSTRAP MODEL. Zachariasen, F. (European Organization for Nuclear Research, Geneva). pp 277-97 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

The use of the multipheral model as a bootstrap theory is reviewed. (13 refs. and 13 Figs.) (Finland)

23913 MULTIPERIPHERALISM AND INCLUSIVE REACTIONS. Pignotti, A. (Univ. of Washington, Seattle). pp 299-325 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

Inclusive reactions have shown great promise to clarify the ideas on hadronic high-energy collisions, and the multiparticle model is a good tool to explore them. Several of the consequences hinge on delicate questions, such as the nature and factorizability of the Pomeranchuk singularity. They serve mainly as a guideline, and provide what is probably a sensible but naive expectation for the experiments that are going to emerge from the new accelerators. (auth) (Finland)

23914 DUALITY AND DUAL MODELS. Thomas, G. H. (Univ. of Helsinki). pp 419-55 of Colloquium on Multiparticle Dynamics. /Byckling, E. (ed.). Helsinki; Univ. of Helsinki (1971).

From Conference on multiparticle dynamics; Helsinki, Finland (25 May 1971).

The review is limited to the so called B_5 phenomenology. The B_5 model gives physical insight into the data when vector exchange is dominant. When pion exchange is important, no new insight results from including the pion trajectory into a dual B_5 model. On the contrary a perfectly reliable model can be constructed treating the pion as an elementary exchange and multiplying this by a dual amplitude to describe the remainder of the interaction. Finally, when pomeron exchange is important, there is no reliable scheme for putting the pomeron and a dual model into the same amplitude. Hence in this case it must be admitted that for reactions where the pomeron is dominant, there is no reliable model at all, which is in contrast to the situation for reactions where vector or pion exchange is dominant. (auth) (Finland)

23915 HIGH-ENERGY PHASE-SHIFT BEHAVIOR AND THE THREE-BODY BOUND STATE. Fournier, A.; Kok, L. P. (State Univ., Groningen, Netherlands). Lett. Nuovo Cim.; 2: No. 24, 1251-5(11 Dec 1971).

In a previous calculation of binding energies of nuclear matter for interactions which consisted of various rank-one separable potentials it was found that in some cases by raising the tail of the phase shift there was a decrease in the nuclear-matter binding energy. From similar calculations for the bound-state three-body problem this phenomenon is not found. Instead it is shown that raising the tail of the phase shift always gives rise to a greater binding energy. (J.F.P.)

23916 SOME ASPECTS OF THE MULTIPLE PROCESS THEORY. Gurvits, S. A.; Daibog, E. I.; Rozental, I. L. (Moscow State Univ.). Yadern. Fiz.; 14: No. 6, 1268-75(Dec 1971). (In Russian).

Principal problems of the multiperipheralism and of collective interactions describing multiple processes, are considered. Hydrodynamical theory is used to interpret the collective interactions. It is shown that at large energies the experiment provides evidence for hydrodynamical theory. Some heuristic possibilities are analyzed. (auth)

23917 CONNECTION OF MEROMORPHIC DUAL AMPLITUDES WITH PHASE DOUBLE SPECTRAL REPRESENTATION. Iroshnikov, G. S. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 14: No. 6, 1265-7(Dec 1971). (In Russian).

It is shown that within an infinite number of equidistant resonances with zero widths, the phase double spectral representation of analytical functions is reduced to the dual amplitudes by Veneziano and Virasoro. (auth)

23918 SOLUTIONS OF A BETHE–SALPETER EQUATION. Hadjioannou, F. T. (Athens Univ.); Kyriakopoulos, E. Int. J. Theor. Phys.; 5: No. 3, 199-210(1972).

The Lorentz symmetry of the Bethe–Salpeter equation is studied in the light-like case for two scalar quarks of different masses interacting via the exchange of a scalar photon, and a new approach is developed for solving the eigenvalue problem of the equation for the general case. The method permits accurate analytic expressions for the spectrum and the wave functions. (auth)

Strong (Baryon No. = 0)

23919 (JINR–P1-6170) SEARCH FOR SHORT-LIVED PARTICLES AND DETECTION OF ONE HAVING $\tau \approx 10^{-14}$ s. Tolstov, K. D. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of High Energy). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The prospects of the search for new short-lived particles in photoemulsions bombarded with the high-energy particles are discussed. The probabilities are calculated for the detection of the following type decays: $X \to \Pi^{\pm} + \Pi^0 \to \Pi^{\pm} + e^+ + e^- + \gamma$; $X \to P + \Pi^0 \to P + e^- + e^+ + \gamma$; $X^0 \to \Pi^+ + \Pi^-$, under condition that X particle has the mass of 1.78 MeV for the first decay and 2.96 MeV for the second one, and the lifetime 2.2×10^{-14} or 3.6×10^{-14} s, respectively. (auth)

23920 (ORO–3992-68) EXISTENCE OF CROSSING-SYMMETRIC AND UNITARY AMPLITUDES IN S-MATRIX THEORY. Atkinson, D. (Texas Univ., Austin. Center for Particle Theory). Jan 1972. Contract AT(40-1)-3992. 47p. Dep. NTIS.

From the lectures given it is found that the Mandelstam equations for the $\pi\pi$ system have many solutions consistent with crossing symmetry and elastic unitarity. A subset of these solutions also satisfies the inelastic constraints above the inelastic threshold. One source of nonuniqueness is the freedom to insert inelastic contributions in the interior of the double-spectral function, and the other source is the freedom to include CDD poles in a finite number of partial waves. (J.F.P.)

23921 INFLUENCE OF HIGHER-ORDER CUT CONTRIBUTIONS AND OF THE ASYMPTOTIC BEHAVIOR OF THE $\pi\pi$ SCATTERING PHASE SHIFT ON THE DECREASING PROPERTIES OF THE ISOVECTOR NUCLEON FORM FACTORS. Brall, U.; Rodenberg, R. (Technische Hochschule, Aachen). Nuovo Cim. 8A: No. 2, 381-415(21 Mar 1972).

The strong decrease of the isovector nucleon form factors in the spacelike region—which empirically can be adequately described by the dipole fit—is investigated through a dispersion-theoretical description of the $\pi\pi \to$ NN scattering amplitude in the ρ-resonance region. To that extent is considered on the right-hand cut besides the elastic contribution the influence of the uncorrelated 2π exchange and on the left-hand cut besides the nucleon pole and the isobar exchange the contributions of box diagrams in the sense of a strip approximation in the Mandelstam plane. It is found that the electric Sachs form factor can be described completely through the nucleon pole and the uncorrelated 2π exchange, whereas for the magnetic form factor one needs in the region below the ρ resonance a contribution which is about $2\frac{1}{2}$ times the magnitude of the nucleon pole. The decrease in the spacelike region is very sensitive to variations of the $\pi\pi$ scattering phase shift above the ρ-resonance. (auth)

23922 HIGH-ENERGY ASPECTS OF A DUAL RELATIVISTIC QUARK MODEL. Venturi, G. (Univ., Bologna). Nuovo Cim.; 8A: No. 2, 431-46(21 Mar 1972).

The high-energy behavior of a previously constructed dual rela-

tivistic quark model for $\pi\pi$ and πN scattering amplitudes is examined in detail. The model has a satisfactory low-energy behavior and no parity doubling or ghosts on leading trajectories, and the leading trajectory residue factorizes into a product of collinear $U_6 \otimes O_2$ invariant vertices. The singularities in the complex angular-momentum plane are examined in detail and the high-energy limit of the functions is explicitly exhibited. The model is found to give satisfactory results for forward πN charge-exchange scattering and backward $\pi^+ p$ scattering. (auth)

23923 MODEL DIFFRACTION TERM. Pancheri-Srivastava, G. (CNEN, Frascati, Italy. Radcliffe Inst., Cambridge, Mass.); Srivastava, Y. N.). Lett. Nuovo Cim.; 3: No. 10, 411-16(4 Mar 1972).

A modification of the Del Giudice-Veneziano ansatz (Lett. Nuovo Cimento, 3, 363 (1970)) for the pomeron (diffractive term) is presented, which gives small corrections to the dual-resonant model meson–meson scattering lengths. Two theoretical applications of the model are presented. The first is in calculating the contributions to scattering lengths for $\pi\pi$ and πK, where the Veneziano resonance formula makes good predictions. The second is to impose continuous PCAC constraints to $K\pi \to K\pi$ and $K\pi \to KA_1$ amplitudes. (L.B.S.)

23924 DIRECT-CHANNEL INTERFERENCE IN $\overline{N}N \to K\overline{K}$ AT LOW ENERGY AND MESON TOWERS. Cline, D.; Rutz, R. (Univ. of Wisconsin, Madison). Phys. Rev., D; 5: No. 3, 778-81 (1 Feb 1972).

The strong suppression of the cross section for the low-energy reaction $\overline{p}p \to K_S^0 K_S^0$ as compared to $\overline{p}p \to K_S^0 K_L^0$ and $\overline{p}p \to K^+K^-$ is explained as being due to the direct-channel excitation of two massive C = +1 boson resonances with I = 1 and I = 0, respectively. It is thus suggested that two $J^P = 2^+$ states with masses below 2.0 GeV and with approximately equal couplings to the $\overline{N}N$ and $K\overline{K}$ systems, and produced in phase, provide a "natural" explanation of the data. Above 1.2 GeV/c the interference effects appear to disappear and possibly a new physical mechanism for $K\overline{K}$ production is observed. (auth)

23925 POSSIBILITIES OF RESONANCE INTERFEROMETRY. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 1, 178-86(Jan 1972). (In Russian).

Possibilities are discussed of the determination of the width of narrow resonances (of the order of a few MeV) with devices of missing mass spectrometer type. The method uses the identical particles interference. The interference peak is of the Breit–Wigner form and may be extended in several times on comparison with the effective mass spectrum peak. In principle, one can consider a special "missing mass interferometers" to resolve the narrow and nearby lying resonance peaks. Observing some special configurations of identical particles one can obtain information about space–time properties of resonances. (auth)

23926 INDIRECT CALCULATION OF THE TRIPLE-POMERON VERTEX AT t = 0. Balazs, L. A. P. (Purdue Univ., Lafayette, Ind.). Phys. Lett.; 37B: No. 5, 528-30(27 Dec 1971).

By associating the triple-pomeron coupling $g_p(t)$ with the renormalization of the pomeron propagator and requiring the latter to correctly reproduce a dual f^0 trajectory, as well as the magnitude and width of the $\pi\pi$ diffraction peak, $g_p(0) \approx \text{GeV}^{-1}$ is obtained. (auth)

23927 ABOUT THE ANOMALY AT 980 MeV IN THE $\pi^+\pi^-$ SYSTEM. Odorico, R. (Argonne National Lab., Ill.). Phys. Lett.; 38B: No. 6, 411-14(20 Mar 1972).

The "anomalous" behavior of the $\langle Y_1^0 \rangle$ moment of the $\pi^+\pi^-$ angular distribution at 980 MeV is shown to arise from a dynamical zero of the $\pi\pi$ scattering amplitude. This effect is unrelated to opening of the K^+K^- threshold, a crucial point of other interpretations. Assuming straight-line propagation of zeros of amplitudes, the positions and characteristics of similar anomalies in all available $\pi\pi$ and $K\pi$ data are correctly predicted. (auth)

Strong (Baryon No. = 1)

23928 (JINR-P2-6230) CHIRAL SU(2) × SU(2) DYNAMICS AND THE REACTION $\pi^+p \to \rho^0\Delta^{++}(1236)$ NEAR THE THRESHOLD. Zaslavskii, A. N.; Lednitski, R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Feb 1972 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The reaction $\pi^+p \to \rho^0\Delta_{1236}^{++}$ is studied in current algebra with the aim of the effective Lagrangians. The full amplitude contains 10 parameters which are determined from the differential cross section at the c.m. energies 2.194 and 2.302 GeV, and from the joint spin density matrix of the ρ^0-meson and the isobar Δ_{1236}^{++} at the energy 2.302 GeV; 105 experimental points are used. Current algebra's results satisfactorily agree with the experimental data. (auth)

23929 (NP-19223) HIGH ENERGY PHENOMENOLOGY OF πN AND KN FORWARD SCATTERING. Note No. 318. Restignoli, M.; Schiff, D.; Violini, G. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 24 May 1971. 15p. Dep. NTIS (U. S. Sales Only).

Recently proposed Regge pole models are tested using FESR in πN scattering. The crossing odd amplitude does not require more sophisticated models than the pure ρ-exchange one. In the crossing-even case several models can reproduce the data within the same accuracy. Also the KN total cross sections are analyzed, and it is found that a conventional model allows one to fit the data within the errors (both statistical and systematic). (auth)

23930 DUALITY SUM RULE FOR DEEP INELASTIC SCATTERING. Parisi, G. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 3: No. 10, 395-6(4 Mar 1972).

A sum rule for the difference between proton and neutron structure functions is derived from the assumptions of duality, SU(3) symmetry, absence of s-channel and t-channel exotic contributions, and the validity of Fubini–Dashen–Gell–Mann sum rule. (L.B.S.)

23931 SPECTRA OF PRODUCED PIONS IN MESON–NUCLEON COLLISIONS IN THE DIFFRACTIVE MODEL. Hwa, Rudolph C. (State Univ. of New York, Stony Brook. Univ. of Oregon, Eugene); Lam, C. S. Phys. Rev., D; 5: No. 3, 766-7 (1 Feb 1972).

The longitudinal-momentum distributions of produced pions in Kp and πp inclusive reactions are calculated in the framework of the diffractive model. Not only is the backward-forward asymmetry predicted, but the absolute slopes are also determined without any parameters in good agreement with experiment. (auth)

23932 THERMODYNAMICAL DESCRIPTION OF PION MOMENTUM DISTRIBUTIONS IN π^-p-INTERACTIONS AT p = 4 GeV/c. Grishin, V. G.; Inogamov, Sh. V.; Yuldashev, B. S.; Yancho, G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 6, 1281-6(Dec 1971). (In Russian).

It is shown that the momentum distributions of secondary pions produced in π^-p reactions at p = 4 GeV/c can be reasonably described by simple functions obtained from the Bose-statistics. The results of the fit are presented for transverse and longitudinal momentum distributions, respectively. A very simple qualitative explanation of the difference of slopes in the $dN/dp_\parallel$ distributions for left- and right-moving pions in the c.m.s. is also given on the basis of the phenomenological quasi-two-body model for high multiplicity interactions. (auth)

23933 ACCOUNT OF SPIN EFFECTS IN REACTIONS OF QUASINUCLEAR MESON PRODUCTION ON ANTIPROTON BEAM. Dal'karov, O. D.; Mandel'tsveig, V. B.; Khangulyan, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 1, 173-7(Jan 1972). (In Russian).

Spin effects in reactions of quasinuclear meson production $d(\bar{p},N)X$ are considered when the reaction amplitude is determined by the replacement mechanism. The generation cross section is calculated as well as the polarization of both emitting nucleons and produced meson. (auth)

23934 INVESTIGATION OF REACTIONS $\pi^-p \to \rho^-p$, $\pi^-p \to \rho^0n$ AT INITIAL MOMENTA 3 TO 8 GeV/c WITH THE COMPLEX ANGULAR MOMENTA METHOD. Guzhavin, V. M.; Kaidalov, A. B.; Nilov, A. F. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 1, 162-7(Jan 1972). (In Russian).

Experimental data on reactions $\pi^-p \to \rho^-p$, $\pi^-p \to \rho^0n$ at 3.25 GeV/c, 4.16 GeV/c, 8 GeV/c are analyzed with the complex angular momentum method. Two models are used: a) the usual Regge pole model, b) a model which takes into account moving branches together with Regge poles. The existing experimental data are shown to be described successfully with both models. The moving branches model description seems to be more natural. Decisive experiments to distinguish the models are proposed. The values of parameters are obtained which characterize the Regge pole residues and the πP-branch. (auth)

23935 t-CHANNEL CONTRIBUTIONS TO THE PION–NUCLEON BACKWARD SCATTERING. Lendel, A. I.; Lend'el, V. I. Uzhgorod State Univ., USSR). Yadern. Fiz.; 15: No. 1, 137-42(Jan 1972). (In Russian).

The structure of the backward differential cross section of πN-scattering is explained by using the dispersion relations for the real part of the scattering amplitude. Very good agreement of the proposed model with the experiment is obtained. (auth)

23936 η AND η' PRODUCTION AT HIGH ENERGIES. Martin, A. D.; Michael, C. (CERN, Geneva). Phys. Lett.; 37B: No. 5, 513-16(27 Dec 1971).

η and η' production by pseudoscalar mesons is discussed.

Small $\eta - \eta'$ mixing is found. Production mechanisms are considered, and an explanation is given for the striking dip which is observed in the $K^-p \rightarrow \eta\Lambda$ cross section at $-t \sim 0.4$ GeV^2. (auth)

23937 SOFT PION THEOREMS IN INCLUSIVE REACTIONS. Sakai, N.; Yamada, M. (Tokyo Univ.). Phys. Lett.; 37B: No. 5, 505-8(27 Dec 1971).

The inclusive cross section of a soft π^0 meson is exactly expressed from PCAC by the nucleon distribution functions. The pion multiplicity correlates to the nucleon multiplicity and increases logarithmically as the energy increases only if the latter remains finite. (auth)

23938 EXOTICS AND RAPID SCALING IN INCLUSIVE REACTIONS. Kugler, M. (Weizmann Inst. of Science, Rehovot, Israel); Rittenberg, V.; Lipkin, H. J. Phys. Lett.; 38B: No. 6, 423-5(20 Mar 1972).

The criteria for rapid scaling in $a + b \rightarrow c + x$ where c is a fragment of a is considered. The assumption that the exoticity of $ab\bar{c}$ implies rapid scaling is shown to lead to rapid scaling if $a\bar{c}$ only is exotic. Experimentally, in one such case rapid scaling does not take place, indicating that the exoticity of $ab\bar{c}$ may not be a sufficient condition. (auth)

Strong (Baryon No. ≥ 2)

23939 (CERN-Trans-71-39) PHASE-SHIFT ANALYSIS OF pp SCATTERING AT 1 GeV. Glonti, L. N.; Kazarinov, Yu. M.; Rozanova, A. M.; Silin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by R. Luther (CERN, Geneva, Switzerland), from report JINR-P1-5737. 12p. Dep. NTIS (U. S. Sales Only).

The assumptions made for the phase shift analysis are that a single-meson approximation is valid for the description of a pp interaction at 1 GeV in states with an orbital moment above 6, that mesons are mainly produced from initial $^3P_{0,1,2}$ $^1D_2$ and $^3F_{2,3,4}$ states, and that the energy dependence of the experimental data used can be ignored and they can be related to 1 GeV within the limits of error. The set of phase shifts describing the experimental data at 1 GeV was obtained by extrapolating the solution found at 630 MeV. The angular dependences of the values observed were calculated in terms of the set of phase-shifts obtained. From this it follows that at present the most useful information for determining the pp scattering amplitude can be obtained only from experiments on triple scattering. (J.F.P.)

23940 (ORNL-TM-3667) MONTE CARLO CALCULATIONS OF HIGH-ENERGY NUCLEON-MESON CASCADES AND COMPARISON WITH EXPERIMENT. Armstrong, T. W.; Alsmiller, R. G. Jr.; Chandler, K. C.; Bishop, B. L. (Oak Ridge National Lab., Tenn.). 5 Jan 1972. 35p. Dep. NTIS.

A Monte Carlo transport code for calculating high-energy nucleon-meson cascades in thick targets is described. The calculational method uses an intranuclear-cascade-extrapolation-evaporation model for treating inelastic collisions ≳3 GeV. Calculated results for the development of the cascade induced in thick iron targets by 10-, 19.2-, 29.4-, and 200-GeV/c protons are presented. For the cases of 10-, 19.2-, and 29.4-GeV/c incident protons, comparisons are made with experimental data and, in general, good agreement is obtained. (auth)

23941 MESON EXCHANGE CORRECTIONS TO THE $p + p \rightarrow d + e^+ + \nu$ REACTION AND TO THE β DECAY OF SOME MIRROR NUCLEI. Rozenblit, Moshe. Hoboken, N. J.; Stevens Inst. of Tech. (1971). 50p. University Microfilms Order No. 72-1631.

Thesis.

The meson exchange corrections to the rate of the $p + p \rightarrow d + e^+ + \nu$ reaction are computed using the method of W. K. Cheng. An increase of 8% was found when a deuteron wave function obtained from a square well potential (compared to 3% obtained by Blin-Stoyle and Papageorgiou, using the same wave functions) was used and 4% when the phenomenological deuteron wave function of Kottler and Kowalski was used. For mirror nuclei with closed core plus one nucleon (or hole), in the zero range approximation, an increase of the decay rate 3.5 times higher than the one found by Blin-Stoyle and Papageorgiou who used a phenomenological approach was found. (Diss. Abstr. Int., B)

23942 REGGE-ABSORPTION MODEL FOR SMALL-ANGLE pp ELASTIC SCATTERING. Caprasse, H. (Univ., Liege). Lett. Nuovo Cim.; 3: No. 10, 427-32(4 Mar 1972).

The present status on the theoretical interpretation of the behavior in the s and t variables of the slope b(s,t) of the pp elastic differential cross section is summarized. A Reggeized absorption model of the Harari kind is constructed, which gives the pp slope at t = 0. The slope of elastic $p\bar{p}$ scattering is computed as a test of the model. Good agreement with existing data is found. (L.B.S.)

23943 RELATIONSHIP BETWEEN HADRONIC AND ELECTRONIC EXCITATION OF N* RESONANCES. Choudhury, S. Rai; Rajaraman, R. (Univ. of Delhi). Phys. Rev., D; 5: No. 3, 773-5(1 Feb 1972).

The question of representing the high-energy diffractive amplitude for $NN \rightarrow NN^*$ by a current-current form is critically examined. (auth)

23944 RISE OF TOTAL CROSS SECTIONS OF COHERENT PROCESSES ON NUCLEI. Grishin, V. G.; Yuldashev, B. S.; Yancho, G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 6, 1276-80(Dec 1971). (In Russian).

It is shown that the rise of cross section of coherent processes with energy may be mainly explained by kinematic factors. (auth)

23945 PION CHARGE EXCHANGE ON LIGHT NUCLEI NEAR (3,3) RESONANCE. Karapetyan, V. V.; Korenman, G. Ya. (Moscow State Univ.). Yadern. Fiz.; 14: No. 6, 1199-1200(Dec 1971). (In Russian).

The cross sections of the positive pion charge exchange on ^{10}B, ^{11}B, ^{13}C nuclei at the incident meson kinetic energy of 180 MeV are calculated in framework of the impulse approximation with plane waves. To describe the nuclei one uses the wave functions of the shell model with intermediate coupling. The integral cross sections of the daughter nucleus production in the bound state are compared with the experimental data and with previous calculations. The possible effect of meson scattering on the charge exchange depending on the structure features of nuclei is discussed. (auth)

23946 CALCULATIONS OF BINDING ENERGY OF THE ^{12}C AND $_\Lambda Be^9$ NUCLEI WITH THE ACCOUNT OF REPULSION. Tuskiya, V. G.; Chilashvili, G. A. (Tbilisi State Univ., USSR). Yadern. Fiz.; 14: No. 6, 1158-64(Dec 1971). (In Russian).

The binding energy of the $_\Lambda Be^9$ and ^{12}C in the ground state was calculated by means of the monomial separable potential with the account of the repulsive core. It was shown that the binding energy strongly depends on the repulsive core radius. (auth)

23947 DOUBLE CHARGE EXCHANGE OF PIONS ON NUCLEI AT HIGH ENERGIES. Gevorkyan, S. R.; Tarasov, A. V.; Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 1, 55-61(Jan 1972). (In Russian).

The double charge exchange of high energy pions ($E_\pi > 2$ GeV) on nuclei being considered at two-step process $\pi^+ \rightarrow (\pi^0, \eta, \rho^0, A_1^0, A_2^0, \ldots) \rightarrow \pi^\mp$ is analyzed in the Glauber theory. Contributions are estimated of some intermediate channels to the double charge exchange cross section. The channels ρ^0, ω, f dominate in the region $2 < E_\pi < 4$ GeV. A numerical estimation of the double exchange cross section on heavy nuclei is obtained. (auth)

23948 DESCRIPTION OF CENTER-OF-MASS MOTION IN THE GLAUBER MODEL. Formanek, J. (Charles Univ., Prague). Czech. J. Phys.; 22: No. 1, 1-8(1972).

The problem of center-of-mass motion of the nucleus is discussed in the framework of the Glauber model, starting from a translation invariance condition. The π-^{4}He coherent scattering amplitude is calculated to illustrate how predictions of the model are sensitive to ways of handling recoil corrections. (auth)

23949 CALCULATION OF SHADOW EFFECTS IN PROTON-DEUTERON COLLISIONS. Anisovich, V. V.; Volkovitskii, P. E.; Dakhno, L. G. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 15: No. 1, 168-72(Jan 1972). (In Russian).

Nonelastic shadow corrections are calculated in the proton-deuteron collisions at the initial proton energy between 15 and 30 GeV. These shadow corrections are shown to depend weekly on the energy. (auth)

23950 SOLUTION OF THE UNITARITY CONDITION WITH A MODIFIED OVERLAPPING FUNCTION. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 15: No. 1, 128-36(Jan 1972). (In Russian).

The unitarity condition for the elastic scattering amplitude is solved in the high energy region with a modified overlapping function. Comparison with the experimental data on the elastic scattering of protons at 19.2 GeV/c is carried out. The theory and the experiment are in agreement for the momentum transfers up to 6 (GeV/c)^2. (auth)

23951 FINE STRUCTURE OF THE POMERON AND THE SLOPE PARAMETER OF THE DIFFRACTION PEAK. Antoniou, N. G.; Baier, R. (CERN, Geneva). Phys. Lett.; 37B: No. 5, 501-4(27 Dec 1971).

The j plane structure of the vertex function of the Pomeron suggested by the two-pole multiperipheral model exhibits a fine structure which depends on the triple Pomeron coupling. It is found that this structure alone may explain the energy dependence of the slope parameter of the p–p diffraction peak even with an arbitrarily small slope of the Pomeranchuk trajectory. (auth)

23952 POSSIBILITY TO MEASURE π AND K-MESON ELECTROMAGNETIC FORM FACTORS IN HADRONIC COLLISIONS. Geshkenbein, B. V.; Terent'ev, M. V. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 37B: No. 5, 497-500(27 Dec 1971).

It is pointed out that there is a possibility to measure the electromagnetic form factor of π and K mesons at large space-like values of q^2 in reaction $\pi(K)$ + nucleus → $\pi(K)$ + nucleus + lepton pair. (auth)

23953 RESTRICTION ON THE BEHAVIOR OF THE ELASTIC AND INELASTIC CROSS-SECTIONS AT HIGH ENERGY. II. Logunov, A. A.; Mestvirishvili, M. A.; Khrustalev, O. A. (Inst. of High Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 9: No. 2, 153-89(Nov 1971). (In Russian).

In this continuation from Part I (which appeared in Vol. 8, No. 1, 1971), short-range nuclear forces and limitations on the cross sections of elastic and inelastic processes are considered. The effective radius of interaction, the equivalence of particle and antiparticle interactions at high energies, and limitations on the total cross section at high energies are topics of interest. Attention is focussed on conditions of unitarity, the upper limit of decrease of the differential scattering cross section, and multiple production with increase of energy. Normal and reciprocal integral concepts, and the concept of Kinoshita, Loeffel, and Martin (1964) are treated. The upper limit of the differential inelastic cross section at large angles and high energies is evaluated. (45 references) (K.S.W.)

23954 SELECTION RULES FOR INCLUSIVE REACTIONS. Lo, S. Y. (Glasgow Univ.); Phua, K. K. Phys. Lett.; 38B: No. 6, 415-18(20 Mar 1972).

Assuming quark model and the hypothesis of limiting fragmentation, selection rules are obtained for inclusive reactions. It predicts $d\sigma(PP \to P + \text{anything}) \gg d\sigma(PP \to \pi^{\pm} + \text{anything}, K^{+} + \text{anything}) \gg d\sigma(PP \to K^{-} + \text{anything}, \bar{P} + \text{anything})$ in agreement with experiments. (auth)

23955 PION–NUCLEUS SCATTERING LENGTHS. Huang, W. T.; Levinson, C. A.; Banerjee, M. K. (Univ. of Maryland, College Park). Phys. Rev., C; 5: No. 3, 651-7(Mar 1972).

The soft-pion theory and the Fubini–Furlan mass dispersion relations were used to analyze the pion–nucleon scattering lengths and obtain a value for the σ commutator term. By using this value and the same principles as above, scattering lengths were predicted for nuclei with mass number ranging from 6 to 23. Agreement with experiment is very good. For those who believe in the Gell–Mann–Levy σ model, the evaluation of the commutator yields the value $0.26(m_{\sigma}/m_{\pi})^2$ for the σ–nucleon coupling constant. The large dispersive corrections for the isosymmetric case imply that the basic idea behind many of the soft-pion calculations, namely, slow variation of matrix elements from the soft-pion limit to the physical pion mass, is not correct. (1 figure, 3 tables) (auth)

23956 UPPER AND LOWER BOUNDS ON PHASE SHIFTS FOR THREE-BODY SYSTEMS: n–d SCATTERING. Carew, John; Rosenberg, Leonard. Phys. Rev., C; 5: No. 3, 658-64 (Mar 1972).

A variational-bound formulation of the three-body problem based on the Faddeev equations has been derived previously. This method involves a variational calculation of the exact effective potential between the incident particle and the bound two-body target. Variational upper and lower bounds on this effective potential are obtained by constructing approximate separable three-body Green's operators. The eigenphase shifts determined by using the effective potential in the two-body Lippmann–Schwinger equation are upper and lower bounds on the true eigenphases for energies below the three-body breakup threshold. The method is applied to the neutron–deuteron system, and a set of variationally converged phase shifts is obtained. (auth)

Particle Invariance Principles and Symmetries

Refer also to abstract 24351.

General

23957 (IFVE-STF-71-26) SOME MACROSCOPIC EFFECTS OF GEOMETRIC SCHEME OF CP-VIOLATION. Arbuzov, B. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

A hypothesis, that the time irreversibility observed (and CP-violation) is connected with noninvariance with respect to time shifts that lead to the effects of energy nonconservation, was put forward. The assumption is realized in the scheme with geometrization of the electromagnetic field, proposed earlier to interpret CP-violation. Some consequences were considered, and it was shown that at the values of the main parameter $l_0 \simeq 10-17$ cm the scheme does not contain any contradictions. (auth)

23958 (JINR–P2-6209) ON THE PECULIARITIES OF THE LIE GROUP APPLICATION TO THE GALILEAN TRANSFORMATIONS. Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that the previously pointed out peculiarities, which are connected with the application of the Lie group theory to the strictly nonrelativistic transformations, take place also in the case of application of the above theory to the Galilean transformations. (auth)

23959 (LNF–71/70) MANIFESTLY CONFORMAL COVARIANT EXPANSION ON THE LIGHT CONE. Ferrara, S.; Gatto, R.; Grillo, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 29 Oct 1971. 18p. Dep. NTIS (U. S. Sales Only).

The isomorphism of the conformal algebra on space-time to the orthogonal O(4,2) algebra is exploited to derive in a manifestly covariant way an operator product expansion on the light-cone in terms of irreducible operator representations of the conformal algebra. The expansion provides for a solution of the causality problem for operator expansion on the light-cone. Additional properties of the conformally convariant expansion, as well as its relation to the conformally invariant three-point function, are discussed. (auth)

23960 LORENTZ-TENSORS AND RELATIVISTIC WAVE EQUATIONS. Glass, Andrew Stuart. Princeton, N. J.; Princeton Univ. (1971). 150p. University Microfilms Order No. 72-2707.

Thesis.

Lorentz-invariant equations of the form, $(\beta_{\mu}\partial^{\mu} + i\chi)\psi(x) = 0$, are analyzed both in terms of the group theory applying to the transformational properties of the β-matrices and in terms of the properties of the matrix algebra generated from the β's. Given Lorentz-invariance, it is shown that the β-algebra has a basis consisting of irreducible tensors constructed from the β-matrices, and that the direct sum of the tensor representations of the Lorentz group which act on this basis is equivalent to the direct product representation $S(g) \otimes S(g)$, where $S(g)$ is the representation of the Lorentz group acting on ψ. It is shown how this theorem can be applied to classifying the possible interactions with external potentials that can be formulated in connection with known free field theories. In order to facilitate such applications, the theory of Lorentz-tensors has been developed in detail. (Diss. Abstr. Int., B)

23961 OPERATOR TREATMENT OF THE GEL'FAND–NAIMARK BASIS FOR SL(2,C). Bars, Itzhak; Guersey, Feza (Yale Univ., New Haven). J. Math. Phys. (N. Y.); 13: No. 2, 131-43(Feb 1972).

An operator form is developed to treat the Gel'fand–Naimark z basis for the homogeneous Lorentz group. It is shown that the operator Z with eigenvalues z, is a definite operator-valued function of the generators of SL(2,C). A unified formulation of the unitary representations of the Lorentz group is obtained in a Hilbert space endowed with an affine metric operator G whose functional dependence on the generators is derived explicitly. The Dirac bra-ket formalism is extended by making a distinction between covariant and contravariant state vectors. The matrix elements of G are shown to coincide with the intertwinning operator of Gel'fand and co-workers. The principal series, the supplementary series, and the two kinds of integer point representations are unified by means of a single scalar product involving the metric operator. (auth)

23962 SU(n-2) x SU(2) x U(1) BASES FOR SU(n). Sharp, R. T. (McGill Univ., Montreal). J. Math. Phys. (N. Y.); 13: No. 2, 183-6(Feb 1972).

Explicit basis states for the general IR of SU(n) are defined in the scheme $SU(n-2) \times SU(2) \times U(1)$; the approach makes use of elementary multiplets. (auth)

23963 CONTRACTIONS OF THE LOW-DIMENSIONAL REAL LIE ALGEBRAS. Conatser, C. W. (Texas Tech. Univ., Lubbock). J. Math. Phys. (N. Y.); 13: No. 2, 196-203(Feb 1972).

A complete and detailed classification and analysis of all the Inonu–Wigner contractions of all the real Lie algebras of dimension 1, 2, and 3 is presented. Starting with a more natural classification of the algebras, many corrections and completions are made to the earlier results of Sharp. Among other things, a proper contraction is constructed between two three-dimensional Lie algebras both of which have two-dimensional derived algebras—a phenomenon previously claimed impossible. (auth)

23964 DECOMPOSITION OF THE PRINCIPAL SERIES OF UNITARY IRREDUCIBLE REPRESENTATIONS OF SU(2,2) RESTRICTED TO THE SUBGROUP SU(1,1) ⊗ SU(2). Cobb, Donald D.; McCliment, Edward R. (Univ. of Iowa, Iowa City). J. Math. Phys. (N.Y.); 13: No. 2, 209-14(Feb 1972).

An explicit form is given for the unitary irreducible representations of the principal nondegenerate series of the group SU(2,2). These representations are then restricted to the subgroup SU(1,1) ⊗ SU(2) and are found to be equivalent to the regular representation of SU(1,1) ⊗ SU(2). (auth)

23965 REALIZATIONS OF LIE ALGEBRAS FROM THE CANONICAL ANTICOMMUTATION RELATIONS. Joseph, A. (Tel-Aviv Univ., Israel). Nuovo Cim.; 8A: No. 2, 217-34 (21 Mar 1972).

With the object of classifying bosons and fermions as composite particles within a given irreducible representation of a Lie group, an analysis is made of the realization of Lie algebras from operators satisfying the canonical anticommutation relations. It is pointed out that for this scheme the total particle number should not be realized, as is generally the case, by a commuting element of the Lie algebra. Some general properties of realizations are considered and, with the above requirement satisfied, several explicit constructions of gl(n + 1) and igl(n) for a system of n degrees of freedom are described systematically, together with procedures for combining an arbitrary number of copies of the given realizations. (auth)

23966 LOW ENERGY THEOREM AND SCALE INVARIANCE AT HIGH ENERGIES. Logunov, A. A.; Mestvirishvili, M. A. (Inst. of High Energy Physics, Serpukhov, USSR). Phys. Lett.; 37B: No. 5, 525-7(27 Dec 1971).

A low-energy theorem on the "c"-particle production with a low momentum is proved. A problem of a scale invariance at high energies is also considered. (auth)

23967 SOME ASTROPHYSICAL SPECULATIONS ABOUT SCALING IN VERY HIGH ENERGY COLLISIONS. Kastrup, H. A. (Univ., Munich). Phys. Lett.; 37B: No. 5, 521-4(27 Dec 1971).

The paper consists of two parts: First, equilibrium distribution functions are discussed under the assumption that binary collisions are dilation on conformally invariant. Second, supposing that "scaling" in several high energy collisions is associated with dilation or (and) conformal invariance at short distances, some speculative astrophysical implications for a hot expanding universe are presented. (auth)

23968 PROBLEMS OF REDUCTION FOR COMPACT GROUPS. Lizin, I. M.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 1, 187-96(Jan 1972). (In Russian).

Some applied problems of compact group reduction are considered. The branch formulas tables in the standard canonical representation were calculated. For the particular form of SU(n) group representations the problems of the reduction with including the transitions between different reduction schemes is shown to be described with the usual angular momentum theory. A physical meaning of this result is briefly discussed. (auth)

Applications (Electromagnetic and Weak)

23969 SECOND-CLASS CURRENTS: SOME MODEL-INDEPENDENT CONSIDERATIONS AND CONCLUSIONS. Beg, M. A. B.; Bernstein, J. (Rockefeller Univ., New York). Phys. Rev., D; 5: No. 3, 714-20(1 Feb 1972).

The problem of second-class currents is studied, and an attempt is made to clarify the situation, by working within the framework of a formulation that makes no appeal to any specific dynamical model of hadronic interactions or nuclear structure. Several new theorems and results are presented. The import of recent experiments is discussed, and a scheme for classification of second-class currents is proposed. (auth)

23970 CP VIOLATION IN τ DECAYS. McCliment, Edward R. (Univ. of Iowa, Iowa City); Teeters, William D. Phys. Rev., D; 5: No. 3, 681-6(1 Feb 1972).

By making use of postulated commutation relations of a CP-violating Hamiltonian with the vector and axial-vector charges of chiral SU(2) × SU(2) symmetry, a theoretical prediction of asymmetry in the slope parameters of $\tau^{\pm}$ decay is obtained in terms of the $K_L \to 2\pi^0$ parameter ϵ'. It is expected that $\Delta = (a^+ - a^-)/(a^+ + a^-) \sim 4\epsilon'$, where $a^{\pm}$ are the slope parameters in the linear matrix-element approximation of $\tau^{\pm}$ decay. With the present experimental limit, $|\epsilon'| \lesssim \frac{1}{5}|\epsilon|$, this gives an upper limit for Δ of 10^{-3}. (auth)

Applications (Strong)

23971 CONSEQUENCES OF BROKEN SU(3) × SU(3) SYMMETRY FOR A LOW ENERGY πK-SCATTERING. Afonin, A. A. (Inst. of High Energy Physics, Alma-Ata, USSR). Yadern. Fiz.; 15: No. 1, 123-7(Jan 1972). (In Russian).

The boundary conditions from the chiral SU(3) ⊗ SU(3) choose a resonance solution for the $P_{\frac{1}{2}}$-wave with parameters $m_{K^*} = 0.99$ GeV, $g^2_{K^*}/4\pi = 1.2$. A not small $S_{\frac{1}{2}}$-wave can serve as indirect evidence against the κ-meson. The necessity of an additional potential used in the dispersion equations is shown. (auth)

Field Theories

General

Refer also to abstract 24006.

23972 SPIN-2 FIELD THEORIES AND THE TENSOR-FIELD IDENTITY. Maheshwari, A. (Univ. of Delhi). Nuovo Cim.; 8A: No. 2, 319-30(21 Mar 1972).

The field theories of Ogivetsky and Polubarinov for universally coupled massive tensor fields are studied. It is shown that, for a one-parameter family of Lagrangians describing the universal interaction of massive tensor fields, the field equation for the tensor field can be put in a form which gives a relation between the total energy-momentum tensor and the tensor field of the type of field-current identity of hadron electrodynamics. A field equation of this structure has been studied by Isham, Salam, and Strathdee in formulating a model for the tensor dominance of gravity. The tensor field in interaction in this class of field theories describes in general a mixture of spin 2 and spin 0 of nonequivalent mass. This class contains one particular solution in which the tensor field is of pure spin 2. The structure of this particular solution should allow one to fix the direct tensor-meson-gravitation coupling in constructing a physical field theory of tensor dominance of gravity (auth)

23973 EINSTEIN'S EQUATIONS AND LOCALITY. Bracci, L. (Univ., Pisa, Italy); Strocchi, F. Commun. Math. Phys.; 24: No. 4, 289-302(1972).

The problem of formulating a local quantum theory of Einstein equations is examined. It is proved that Einstein equations cannot hold as operator equations if written in terms of a potential $h_{\mu\nu}(x)$ which is a weakly local field. This result is independent of the kind of metric chosen in the Hilbert space and it doesn't require covariance of $h_{\mu\nu}$. As a consequence, the peculiar features of the radiation gauge method, i.e., non locality and noncovariance, appear as necessary features of any solution not involving unphysical particles. (auth)

Quantum Field Theory

Refer also to abstract 23918.

23974 (JINR-P2-6174) ON THE RELATIVISTIC TWO BODY PROBLEM IN QUANTUM MECHANICS. Matora, I. M. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Neutron Physics). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A relativistic equation for stationary states of two interacting Dirac type fermions is postulated. The equation is constructed analogously to the Breit equation and differed from the latter by the fact that in the suggested equation the retardation is taken into account through the Lienard–Wiechert potentials. (auth)

23975 (LNF-71/80) DYNAMICS OF CONFORMAL FIELD THEORIES. I. EXACT INVARIANCE. Parisi, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 26 Nov 1971. 9p. Dep. NTIS (U. S. Sales Only).

The constraints that exact conformal invariance puts on the

various Green functions are written. Conformal invariance is used to determine the solutions of the Dyson equation for the vertex and of the unitarity equation for the propagator. They are reduced to numerical equations and their solution fixes the value of the dimension. The relations with the Callan–Symanzik equation are briefly discussed. (auth)

23976 INTERACTING-FIELD PROPAGATION. Shamaly, A.; Capri, A. Z. (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 3: No. 11, 467-71(11 Mar 1972).

The analysis of hyperbolic systems of equations using the method of characteristic surfaces was previously used to determine the causal nature of the propagation of spin-$\frac{3}{2}$ and spin-1 fields. The results of an investigation extending some of the previous results for spin-1 and spin-$\frac{3}{2}$ as well as an investigation of the various couplings between a spin-$\frac{1}{2}$ (Dirac) and spin-1 (Proca) field are reported. (L.B.S.)

23977 GENERALIZED-LORENTZ-GAUGE DESCRIPTION OF QUANTUM ELECTRODYNAMICS. Tomczak, S. P.; Haller, K. (Univ. of Connecticut, Storrs). Nuovo Cim.; 8B: No. 1, 1-26 (11 Mar 1972).

A unified formulation of quantum electrodynamics in the generalized Lorentz gauge (including, for example, the Feynman, Landau and Yennie gauges) is presented. The formulation is shown to be consistent with the appropriate commutation relations and propagators in the various gauges. All the gauge descriptions are shown to lead to Maxwell's equations in the Lorentz gauge provided that expectation values of the electric and magnetic field intensities are taken over physically admissible states. It is shown that when the subsidiary condition is properly treated for the case of interacting photons and charged particles, the various gauge descriptions have the same physical content and electron wave function renormalization constants as the Coulomb gauge. (auth)

23978 OPERATORS FOR THE SPACE–TIME CODE. Morris, H. C. (University Coll., London). Nuovo Cim.; 8B: No. 1, 142-56(11 Mar 1972).

Representations of the "position operators of a quantized light-cone" proposed by Finkelstein are explicitly constructed. The spectra of these operators are determined and the "time operator" is found to be discrete. Commutation properties and the question of the classical limits of the operators involved are considered. (auth)

23979 USE OF COHERENT STATES IN OPERATOR ALGEBRA. Gluck, P. (Bar-Ilan Univ., Ramat-Gan, Israel). Nuovo Cim.; 8B: No. 1, 256-60(11 Mar 1972).

The coherent-state method is applied to find the normal form of functions of boson creation and annihilation operators. The method is applicable, in addition, to simple evalaution of commutation relations as well as to proving operator identities of interest in radiation and quantum field theory. Examples are given to illustrate the method. (auth)

23980 TIMELIKE ASYMPTOTIC SERIES OF ALMOST LOCAL FIELDS. Voelkel, A. H. (Freie Univ., Berlin). J. Math. Phys. (N. Y.); 13: No. 2, 257-68(Feb 1972).

Timelike asymptotic series for many-particle matrix elements of products of almost local fields are derived which generalize and extend the Araki–Haag series of quasilocal operators. An interpretation of the asymptotic leading terms in the form of contributions from disconnected intermediate particle states is given. A discussion of the dependence of the asymptotic leading terms on the smearing in the space variables is presented. (auth)

23981 VARIATIONAL METHODS IN THE WAVE OPERATOR FORMALISM: APPLICATIONS IN VARIATION-PERTURBATION THEORY AND THE THEORY OF ENERGY BOUNDS. Braendas, Erkki J.; Micha, David A. (Univ. of Florida, Gainesville). J. Math. Phys. (N. Y.); 13: No. 2, 155-60(Feb 1972).

Variational principles of the Lippmann–Schwinger type are used to develop approximations to eigenenergies and eigenfunctions within the wave-operator formalism. The present approach starts with exactly soluble "primary" eigenvalue equations to give explicit results valid beyond the limits of conventional perturbation theory. The variational functionals are expressed in terms of resolvents of the primary Hamiltonian, and bounds to the functionals are constructed also for cases where the resolvents are only partly known. Approximations to eigenenergies and eigenfunctions are obtained in terms of quantities in the Brillouin–Wigner perturbation theory. Connections with methods for upper and lower energy bounds are discussed, and the convergence properties of the nonlinear Padé summation is recovered in this way. Closed formulas within the double perturbation theory framework are presented as a logical extension. (auth)

23982 SUPERPROPAGATORS OF NON-LOCALIZABLE FIELDS. Flume, R. (Univ., Hamburg). Commun. Math. Phys.; 24: No. 4, 303-9(1972).

Arguments are given for a special choice of the superpropagator corresponding to Wightman-two-point-functions with an increase in momentum space as $e^{k|p^0|^{\kappa}}$, $\kappa > 0$. (auth)

23983 ASPECTS OF MASSIVE GAUGE FIELD THEORIES. Barnebey, Thomas Arthur. Los Angeles; Univ. of California (1971). 229p. University Microfilms Order No. 72-2772. Thesis.

Part One. Derivation of a Chiral Lagrangian from Scalar Curvatures — A spinor Lagrangian invariant under global coordinate, local Lorentz and local chiral SU(n)XSU(n) gauge transformations is presented. The invariance requirement necessitates the introduction of boson connection fields in covariant derivatives of the spinors, and a Lagrangian for these fields is developed in Part One. This is done by relating the spinor connections to generalizations of the vector connections in general relativity, and using the sum of the generalized scalar curvatures as a Lagrangian. Essentially, the relations between the spinor connections and vector connections are postulated by matching their respective local Lorentz and local gauge transformation properties. The independent boson fields of the theory are assumed to be the inhomogeneously transforming irreducible parts of the vector connections. It turns out that no homogeneously transforming parts are necessary to reproduce the chiral Lagrangian usually used as a basis for phenomenological field theories. The final theory includes gravitons, vector bosons, axial vector bosons and fermions. The vector bosons are massive in spite of the fact that the Lagrangian is gauge invariant.

Part Two. Equal Time Commutators of a Phenomenological Field Theory — The theory derived in Part One is considered in the limit when the gravitational interaction is turned off. It is found that if some of the vector fields are assumed to vanish in one gauge, pseudo-scalar fields appear naturally in another gauge as group parameters. The latter is therefore christened the physical gauge. The group space geometry is reviewed and applied to develop a group space covariant formalism for doing classical and quantum mechanical calculations involving the pseudo-scalar fields. For example, covariant canonical commutators are defined. Although the group parameter formalism is convenient, it is shown that the group space coordinates appearing in the chiral Lagrangian cannot describe physical pseudo-scalar particles unless the theory is modified. A modification which leads to a successful phenomenological Lagrangian is made, and the equal time commutators of the fields and currents associated with the new theory are computed. By utilizing the group space covariant commutation rules, these computations are considerably simplified.

Part Three. Ward-Takahashi Relations in the Massive Yang-Mills Theory — The simple SU(2) massive Yang–Mills Lagrangian is found to be a special case of the flat space chiral Lagrangian in Part Two. The equivalence of massive Yang–Mills theory to a theory of vector electrodynamics with a massive photon is reviewed, and the resultant Feynman rules are used together with non-local SU(2) invariance to derive Ward–Takahashi relations among the corrected vertices which are valid to all orders. One of these is employed to find a new Ward identity. A brief discussion of divergence problems is given.

Part Four. Functional Formulations of the Massive Yang-Mills Theory — Beginning with Feynman's functional integral formulation of quantum field theory, two functionals are derived which generate S-matrices of the massive Yang–Mills theory. The first has the form of a functional differential operator acting on the generating functional of a linear theory. The second incorporates an integral over group space coordinates, and it is shown that these coordinates enter the integrand only as arguments of the j = 1 irreducible representation functions of SU(2). (Diss. Abstr. Int., B)

23984 COVARIANT DIASTROPHIC QUANTUM FIELD THEORY. Klauder, John R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 12, 769-72(20 Mar 1972).

Elementary arguments determine the operator superstructure for a special but broad class of covariant field theories. Field operators and generators of interest are shown to be bilinear expressions in conventional creation and annihilation operators. Nontrivial interaction is incompatible with canonical (anti) commutation relations. (auth)

23985 THEOREM OF ADDITION OF VELOCITIES IN SPECIAL RELATIVITY. Schaer, J. (Univ. of Calgary, Alberta). Fizika (Zagreb); 4: No. 1, 73-5(Jan 1972).

The theorem of addition of velocities in special relativity is treated by a method using the fundamental invariance of the four-dimensional scalar product. This method although known merits

attention because it avoids the choice of specific coordinates, explicit Lorentz transformations, and many laborious calculations. (J.F.P.)

23986 WYLER'S DERIVATION OF THE FINE-STRUCTURE CONSTANT. Schwartz, H. M. (Univ. of Arkansas, Fayetteville). Lett. Nuovo Cim.; 2: No. 24, 1259-60(11 Dec 1971).

It is shown that the odds against Wyler's fine-structure constant derivation being purely fortuitous are not entirely compelling, but that if the result found by Wyler is well grounded physically then whatever the eventual theory in which it is embedded the implications point to an intimate connection between electrodynamics and quantum theory. (J.F.P.)

23987 RELATIVISTIC MOTIONS ISOMETRIC WITH RESPECT TO A PARTICLE. Soederholm, Lars (Univ. of Stockholm). Phys. Scr.; 4: No. 1-2, 7-10(1971).

A recently formulated principle of objectivity for relativistic continuum mechanics turns out to be closely connected with a class of relativistic motions. Such motions will be called isometric with respect to a particle. A motion is shown to be isometric with respect to a particle Z_0 if and only if the distance between each pair of particles is time independent when measured in rest frames for Z_0. It is shown that the class of motions, which are isometric with respect to Z_0, and in which the distances between the particles are given, has six degrees of freedom. The velocity field of such motions is determined. The motions isometric with respect to a particle are compared with the motions introduced by Born in his second attempt to take over the concept of rigid body to relativity. (auth) (Sweden)

23988 CHIRAL CURRENTS AS FIELD VARIABLES IN A SEMICLASSICAL APPROACH. Moya, R. P.; Valatin, J. G. (Queen Mary Coll., London). J. Phys., A(London); 5: No. 3, 348-64(Mar 1972).

The ways in which the 4-vector currents and invariants carried by an 8-component spinor field can appear as dynamical variables are investigated in the framework of a c-number theory. Simple derivations are given to a number of identities containing space-time derivatives of the currents and invariants. Expressions for the energy-momentum tensor and other tensors, for Lagrangian densities and the resulting field equations all show symmetries and simple transformation properties with respect to isospin and chiral SU(2) × SU(2) transformations which, through the tetrad structure of the chiral currents, are connected with space-time properties. Contributions to field equations from different parts of a Lagrangian are given in a form that remains valid in the presence of other interaction terms and exhibits the presence of tetrad fields. Different choices of independent variables lead to complementary descriptions. (auth)

Gravitation and General Relativity

Refer also to abstracts 23867 and 23967.

23989 (JINR-E2-6216) TIME-DEPENDENT YUKAWA POTENTIALS OF A CLASS OF WEAK GRAVITATIONAL FIELDS. Nedelkov, I. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 8p. Dep. NTIS (U. S. Sales Only).

The central-symmetric solutions of a class of generalized gravitational equations are obtained. The computations are made in the Newtonian limit. The solutions contain terms both of Newtonian and Yukawa type. The latter are time-dependent. (auth)

23990 GRAVITATIONAL-FIELD ANGULAR-MOMENTUM TRANSFER IN GENERAL RELATIVITY. Booth, D. J. (Univ. of Wales, Swansea); Cooperstock, F. I.; Rumsey, J. D. Nuovo Cim.; 8B: No. 1, 90-104(11 Mar 1972).

A formalism for gravitational-field angular-momentum transfer is developed in analogy with Einstein's gravitational-energy transfer. The transfer is expressed in terms of the quadrupole moments of the interacting matter distributions and verified by computing the gravitational-field angular-momentum flux over an infinite sphere which arises from their interaction. Orbital as well as intrinsic angular momentum may come into play and two simple examples are given. A knowledge of angular-momentum transfer yields a far more detailed physical description of the interaction than that which is possible from energy transfer alone. (auth)

23991 MAPPING ONTO SOLUTIONS OF THE GRAVITATIONAL INITIAL VALUE PROBLEM. York, James W. Jr. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 13: No. 2, 125-30(Feb 1972).

Two approaches to the Einstein initial value problem for vacuum gravitational fields are considered. In the first, the metric of a spacelike slice is prescribed arbitrarily and it is shown that momenta satisfying the constraints can be constructed by exploiting the well-known relation of three of the four constraints to the three-dimensional coordinate transformation group. Specifically, it is shown that there exists a coordinate mapping of a certain specified set of functions onto momenta satisfying the constraints for a specified 3-metric. A further interpretation of this procedure is discussed. In the second approach the 3-geometry of a spacelike slice is specified up to a conformal factor. It is shown that, using a coordinate transformation method similar to the above, transverse traceless momenta can be constructed and that this construction depends essentially only on the conformal geometry of the spacelike hypersurface. The remaining constraint is satisfied by a choice of the conformal factor. As a result, it follows that the initial value equations can be satisfied by mapping certain specified sets of functions onto solutions by using coordinate transformations and a group of scale transformations which include conformal transformation of the metric. This is significant because the unconstrained initial data (gravitational degrees of freedom) are represented by a pair of scale-invariant transverse, traceless tensors of weight $\frac{1}{2}$. These objects, in turn, give irreducible representations of the coordinate and scaling groups which are used to effect solutions of the initial value equations. (auth)

23992 IMPROBABILITY OF COLLISIONS IN NEWTONIAN GRAVITATIONAL SYSTEMS. Saari, Donald Gene (Northwestern Univ., Evanston, Ill.). Trans. Amer. Math. Soc.; 162: 267-71 (Dec 1971).

It is shown that the set of initial conditions leading to a collision in finite time has measure zero. (auth)

23993 SPACE-TIMES OF THE TAKENO TYPE. Vincensini, P. Dominique. Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 6,640-5 (1971). (In French).

It is shown that in the particular case where θ = constant, one can define on a Takeno-type space-time a singular electromagnetic field (of pure radiation), and if in addition β = constant, the Takeno-type space time is of a type called N in the Petrov classification. (J.F.P.)

23994 GRAVITATIONAL RADIATION REACTION. Lind, Robert W. (Syracuse Univ., N. Y.); Messmer, James; Newman, Ezra T. Phys. Rev. Lett.; 28: No. 13, 857-8(27 Mar 1972).

The results of an exact calculation of the equations of motion (with gravitational radiation reaction terms) of a gravitating system subject to no external forces are presented. (auth)

23995 NEWTONIAN GRAVITATIONAL THEORY: INTERACTION WITH LIGHT. Schwebel, Solomon L. (Boston Coll., Chestnut Hill, Mass.). Int. J. Theor. Phys.; 5: No. 1, 29-33 (1972).

The interaction of light with the gravitational field of a mass point described by a Newtonian gravitational field theory gives the same gravitational red shift as accepted theory. The dual force which is an integral part of the classical field theory and which has been shown to give the same advance of the perihelion of the orbit as Einstein's general theory of relativity is also the reason that light is deflected in the neighborhood of a massive particle. The deflection predicted is slightly more than 10% larger than Einstein's value, but within the experimental error of observational data. The dual force and its effects must be taken seriously. Its role in electrodynamics and quantum mechanics is briefly discussed. (auth)

23996 INTERACTION IN SCALAR THEORIES OF GRAVITATION. Linden, Tom L. J. (European Space Operations Centre, Darmstadt Ger.). Int. J. Theor. Phys.; 5: No. 2, 127-9(1972).

It is shown that Bergmann's (1956) scalar field theory is similar to Nordström's (1912) theory. The interaction term in the former's theory is equivalent to nonlinearising the Nordström theory by including twice the energy density of the field as a source term in the "Poisson-like" equation. It is further shown that, if the interaction term $(1 + \nu)$ in Bergmann's theory is replaced by $(1 + \nu)^2$, then the subsequent field equation appears more reasonable in that the energy density (not twice) appears as a source term. (auth)

23997 SOME PHYSICAL PROPERTIES OF NEUTRINO-GRAVITATIONAL FIELDS. Griffiths, J. B. (University Coll. of North Wales, Bangor). Int. J. Theor. Phys.; 5: No. 3, 141-50(1972).

A new solution of the Einstein-neutrino field equations is given. The solution is of Plebanski class $[4N]_2$ and describes a beam of neutrinos propagating along straight geodesics but possessing an inherent angular momentum density. Another previously known solution is also examined, and using some calculations given by

Bonnor it is concluded that a uniform beam of neutrinos is gravitationally stable and that two such beams radiating in the same sense do not interact. (auth)

23998 OBSERVER DEPENDENCE OF CELLULAR SPACE-TIME STRUCTURE. Cole, E. A. B. (Univ. of Leeds, Eng.). Int. J. Theor. Phys.; 5: No. 1, 3-14(1972).

It is argued that space-time has a cellular structure, the exact structure being observer-dependent and consistent with the amount of effort he has available for refining his measuring apparatus. The usual concept of a single distance in continuous space is replaced by the concept of a distance set between cells, the elements of each set depending on the cellular structures of both the space and the measuring rod that is used in the measurement. The idea that there are many different ways of measuring the same observable is abandoned; instead, the definition of the original observable becomes split by the different measuring processes used, and the results of a measurement of each new observable defined by this splitting are predicted from the eigenvalues of a common operator by using an observer-dependent construction. Transformations between observers with different cellular structures are considered. The transformation is not as exact as in the continuous case, with at best a cell of one space being associated with a set of cells in the other. This transformation is determined by information being exchanged by the observers concerning the locations in their two spaces of a finite number of common events. The transformation becomes more exact as more information is exchanged. (auth)

23999 COORDINATE GROUP SYMMETRIES OF GENERAL RELATIVITY. Bergmann, P. G. (Syracuse Univ., N. Y.); Komar, A. Int. J. Theor. Phys.; 5: No. 1, 15-28(1972).

The principal purpose is to attempt to elucidate the relationship between the three symmetry groups associated with the general theory of relativity. The need for this arises in part from the attempt to find the observables of gravitation theory, that is, the functionals of the field variables that are invariant under space-time mappings, such observables appearing necessary if a quantum theory of gravitation is to be constructed. The assertion is also made that in general relativity the identity of a world point is not preserved under the theory's widest invariance group. This assertion forms the basis for the conjecture that some physical theory of the future may show how to dispense with world points as the ultimate constituents of space-time. (UK)

24000 GEOMETRIZATION OF FORCES. Quale, Andreas (Princeton Univ., N. J.). Int. J. Theor. Phys.; 5: No. 2, 79-99(1972).

The problem of giving a geometric description of external forces acting on general charged test particles is discussed, within the framework of general relativity. The concept of a pointlike test particle is analyzed, and it is found possible to introduce a strongly localized interaction between the particle and external fields, while still retaining the notion of a test (i.e., nonradiating) particle, in such a way that the particle trajectory is geodesic in the local space-time geometry, irrespective of the charges coupling it to external matter fields or to space-time curvature. The phenomenon of deviation, due to differential forces between identically charged noninteracting point particles, is also considered; it is found that a geometric description of such forces requires introducing additional geometric objects into space-time, making it non-Riemannian. It is shown that a quite general differential force may be described geometrically as a geodesic deviation in a nonsymmetric affine space, endowed with a torsion field. The physical properties of the torsion, and its relation to geometrodynamics, are discussed. (auth)

24001 STATIC PERFECT FLUIDS IN GENERAL RELATIVITY. Barnes, A. (Imperial Coll. of Science and Tech., London). J. Phys., A (London); 5: No. 3, 374-93(Mar 1972).

All solutions of Einstein's field equations which represent a static perfect fluid are considered and a number of results for vacuum fields obtained by Ehlers and Kundt are generalized. All such solutions with a degenerate Weyl tensor are found explicitly. As is the case with vacuum fields of Ehlers and Kundt all the solutions obtained are found to admit at least a two-parameter group of local isometries. (auth)

24002 POLARIZATION OF A SPINOR VACUUM BY A GRAVITATIONAL FIELD. Papyrin, A. F. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 475-7(Jul-Aug 1971). (In Russian).

The polarization of a vacuum spinor field by a slowly changing gravitational field was investigated by the method of I. Schwinger. The vacuum contribution to the Lagrange gravitational field (the latter being identifiable with the cosmological constant Λ) was calculated. (K.S.W.)

24003 NEW PHYSICAL CHARACTERIZATION OF STATIONARY AND STATIC SPACE-TIME. Mueller zum Hagen, H. (King's Coll., London). Proc. Cambridge Phil. Soc.; 71: Pt. 2, 381-9(Mar 1972).

A space-time is stationary if and only if it admits a congruence of time-like curves such that the distance between any two curves is time independent. The distance between two curves A and B, which are not necessarily infinitesimally close to each other, is defined as half the trip-time of a photon, which travels from A to B and back to A. (auth)

24004 NEW SOLUTION OF EINSTEIN'S EQUATIONS WITH A COSMOLOGICAL TERM. Gorelik, G. E. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4. 477-9(Jul-Aug 1971). (In Russian).

Assuming a plane space and given metrics, the effect of a cosmological term in an anisotropic model of the universe was investigated in connection with Einstein's equations. The dependence of V on the time "during the first minute" after explosion and the effect of the Λ-term were discussed. The outcome of the mathematical development suggests that the "cooking of the elements" may have occurred in different ways depending on the magnitude and the sign of Λ. (K.S.W.)

24005 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. XII. CORRESPONDENCE BETWEEN TOROIDAL AND CYLINDRICAL WAVES. Marder, L. (Univ. of Southampton, Eng.). Proc. Roy. Soc. (London), Ser. A; 327: No. 1568, 123-30(22 Feb 1972).

A device making use of the linearity of one of the field equations for Rosen's cylindrically symmetric metric is employed to demonstrate a correspondence between some outgoing toroidal gravitational waves and imploding-exploding cylindrical waves. An exact form of axially symmetric metric for a smooth toroidal pulse in the region $|z| < t$ (in coordinates which approximate to cylindrical polars when the field is weak) is constructed, and extensions to the region $|z| > t$ are considered. The solution remains valid throughout the reflexion of the wave as it meets itself on the symmetry axis, and displays this process clearly. As a particular example, a solution of Weber & Wheeler (Rev. Mod. Phys. 29: 509(1957)) for a nonsingular cylindrical pulse is converted into one for a time-symmetric toroidal pulse, and the distant field at the moment of time-symmetry is briefly examined. (auth)

Scattering Theory

24006 (JINR-E2-6215) GROUP INTERPRETATION OF THE DUAL TRANSFORMATIONS IN THE COHERENT STATE SPACE. Popov, C. D.; Stoyanov, D. Ts.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 27p. Dep. NTIS (U. S. Sales Only).

A representation of the group SL(2,R) is obtained, that performs the dual transformations in the space of coherent states of one 5-dimensional oscillator. This representation is applied for factorization of the dual N-point amplitude, corresponding to a semi-multiperipheral configuration of the external particles. (auth)

24007 (JINR-P2-6199) APPLICATION OF THE PERTURBATION THEORY TO SOLVING THE SCHROEDINGER EQUATION FOR A RELATIVISTIC TWO-PARTICLE SYSTEM. Atanasov, A. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

The perturbation theory method is applied to solving the two-particle relativistic problem for a system described by the Yukawa potential. The relativistic Balmer formula is obtained and conditions of its application are studied as well as the Regge poles for the two-particle relativistic scattering amplitude and its asymptotic behavior. (auth)

24008 EXISTENCE AND COMPLETENESS OF WAVE OPERATORS IN NONRELATIVISTIC SCATTERING. O'Carroll, M. (Pontificia Univ. Catolica, Rio de Janeiro). Nuovo Cim.; 8B: No. 1, 27-34(11 Mar 1972).

A new direct proof of the existence of the wave operators $W_\pm = \text{s-lim}_{t\to\pm\infty} \exp[iH_2t] \exp[-iH_1t]$ of nonrelativistic quantum mechanics is given. Also the results of Prosser and Hunziker for the two- and three-body cases on L^2 completeness are extended and an error in the literature is corrected. (auth)

24009 NEW POINT OF VIEW IN THE ANALYSIS OF TWO-BODY REACTIONS. Barrelet, E. (Ecole Polytechnique, Paris). Nuovo Cim.; 8A: No. 2, 331-71(21 Mar 1972).

An original method for the analysis of two-body reactions is presented, based on the use of the zeros of the scattering amplitude. (auth)

24010 EXAMPLE OF PERTURBATION THEORY FOR SINGULAR POTENTIALS. Vainberg, V. M. (Inst. of Theoreti-

cal and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 6, 1287-93(Dec 1971). (In Russian).

Scattering phase shifts on the singular potential are represented as a series in powers (not only integer) of dimensionless parameter βk^{n-2}. It is shown that such an expansion converges at any value of this parameter. (auth)

24011 HIGH-ENERGY EFFECTS IN THE N/D METHOD. Gibbons, Thomas; Dilley, James (Ohio Univ., Athens). Phys. Rev., D; 5: No. 3, 762-5(1 Feb 1972).

A discussion of high-energy effects in the N/D method is presented and arguments are given that difficulties of the type described by Coulter can be avoided. (auth)

24012 INTRODUCTION OF NONCOMMUTING OPERATORS INTO TRAJECTORIES OF DUAL MODELS. Ansel'm, A. A.; Danilov, G. S.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 15: No. 1, 150-61(Jan 1972). (In Russian).

The dual model is considered with trajectories which are linear functions of the channel isospin squared. It is shown that in spite of the fact that the operators of isospin of different channels do not commute such a model leads to main trajectories with conventional properties: absence of exotic states and factorization of the bootstrap type. On the level of the daughter trajectories the following nonfactorizable singularities inevitably appear: (depending on details of the model) either branch points or nonfactorizable poles. The question is discussed of the introduction (using the developed formalism) of the Pomeranchuk pole into the duality scheme so that it would be dual to singularities in exotic channels only on the daughter levels. (auth)

24013 DUAL RESONANCE MODEL FOR NONEQUAL REGGE TRAJECTORIES; N-REGGEON VERTEX. Gedalin, E. V. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 15: No. 1, 143-9 (Jan 1972). (In Russian).

An expression is obtained for the symmetric N-Reggeon vertex in the dual resonance model with a given finite number of distinct Regge trajectories. The regularization and asymptotics of one loop diagrams are discussed. (auth)

24014 EXPONENTIATION AND SUM RULES. Weinberg, S. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett.; 37B: No. 5, 494-6(27 Dec 1971).

The eikonal approximation is applied to the scattering of a fast particle of arbitrary spin in a slowly varying external electromagnetic field. It is found that "exponentiation" occurs only for the gyromagnetic ratio g = 2, when transitions to excited states are ignored. However, when transitions to excited states are included, exponentiation always occurs, provided that the anomalous magnetic moment obeys a generalized version of the Drell–Hearn sum rule. (auth)

24015 HYPERSPHERICAL FUNCTIONS OF TREE TYPE IN THE n-BODY PROBLEM. Kil'dyushov, M. S. (Moscow Physical-Technical Inst.). Yadern. Fiz.; 15: No. 1, 197-208 (Jan 1972). (In Russian).

The matrix elements of a unitary transformation between bases corresponding to different topological structure graphs of the "tree" type are calculated. Their connection with Clebsch–Gordan coefficients is established. (auth)

24016 TWO-POMERANCHUKON CUTS AND VANISHING OF THE TRIPLE-POMERANCHUKON COUPLING. Muzinich, I. J.; Paige, Frank E.; Trueman, T. L.; Wang, Ling-lie (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 28: No. 13, 850-3(27 Mar 1972).

It is shown that the Gribov–Migdal lower bound on the magnitude of the two-Pomeranchukon cut is not valid unless both the triple-Pomeranchukon coupling $g_{PPP}(t,q_1^2, q_2^2)$ and its derivative $dg(t,q^2,q^2)/dq^2$ vanish when $t = q_1^2 = q_2^2 = 0$. A numerical estimate of the cut is given. The connection is given between the behavior of g_{PPP} and the validity of the Bronzan and Jones unitarity condition on the discontinuity of the cut at t = 0. (auth)

24017 SUM RULES FOR DISCONTINUITIES AND UNITARITY EQUATIONS. Uschersohn, I. (Univ. of Lund, Sweden). Phys. Lett.; 38B: No. 6, 426-8(20 Mar 1972).

The sum rules for elementary discontinuities of inelastic scattering amplitudes, derived by Veneziano, are shown to be inconsistent with the definition of the discontinuities. New sum rules are derived. Each of the sum rules is equivalent to the basic discontinuity formula. (auth)

24018 SIMPLE NUMERICAL SOLUTION OF THE PARTIAL-WAVE LIPPMANN–SCHWINGER EQUATION. Stern, M. S. (Univ. of Hull, Eng.). J. Phys., A (London); 5: No. 3, 426-30 (Mar 1972).

The partial-wave Lippmann–Schwinger integral equation is reduced to a system of simultaneous linear equations at negative energies and the negative energy solution is analytically continued to positive energies by means of Padé approximants. This method of solution is suitable for application to interactions which contain both attractive and repulsive regions, as well as to purely attractive or purely repulsive potentials. (auth)

PHYSICS (LOW-TEMPERATURE)

24019 PROGRESS IN LOW TEMPERATURE PHYSICS. VOLUME VI. Gorter, C. J. (ed.). New York; American Elsevier Publishing Company, Inc. (1970). 449p. $23.00.

Ten papers are included, a separate abstract was prepared for each of the eight papers selected. The other two papers, "Critical Behavior in Magnetic Crystals" by R. F. Wielinga and "Diffusion and Relaxation of Nuclear Spins in Crystals Containing Paramagnetic Impurities," by G. R. Krutsishvili were not in scope for NSA. (M.H.R.)

For abstracts of individual papers see: 24037–24039, 24171–24174, and 24206.

Superfluidity

Refer also to abstract 24083.

24020 (NP-19221) CALCULATION OF CRITICAL INDICES. Note No. 322. Parisi, G.; Peliti, L. (Rome Univ. (Italy). Istituto di Fisica). 12 Jun 1971. 6p. Dep. NTIS (U. S. Sales Only).

An approximation is found from which the calculation of critical indices for the λ-point of Bose liquids is reduced to quadratures. (auth)

24021 DIFFUSION OF METASTABLE SYSTEMS PRODUCED BY α PARTICLES IN LIQUID ^{3}He–^{4}He SOLUTIONS. Roberts, H. A. (Univ. of Virginia, Charlottesville); Hereford, F. L. Phys. Lett.; 38A: No. 6, 395-7(13 Mar 1972).

Measurement of the scintillation intensity produced by α particles in liquid ^{3}He–^{4}He solutions provided information concerning the diffusion and structure of metastable systems in liquid helium. (auth)

24022 GROSS–PITAEVSKII EQUATION FOR A STRONGLY INTERACTING SUPERFLUID BOSON SYSTEM. Kobe, D. H. (North Texas State Univ., Denton). Phys. Rev., A; 5: No. 2, 854-61(Feb 1972).

The Gross–Pitaevskii equation for the order parameter of a superfluid boson system is derived in a form that is applicable to a system in which the two-body potential has a strong repulsive core, as is the case for liquid helium. The equation of motion for the order parameter, defined as the matrix element of the field annihilation operator between the states of an $(N-1)$-particle and an N-particle system, is obtained. The term describing the average potential due to the other particles is expanded in a perturbation series, in which the coherent-state representation is used. The resulting expansion is the same as using the Bogolyubov approximation and Wick's theorem, and shows that the Bogolyubov expansion is exact in the limit of an infinite number of particles. The perturbation expansion is partially resumed to give a Hartree field in which the potential has been replaced by the T matrix, which gives a finite average effective field. (auth)

24023 COMMENT ON ANALYSIS OF TEMPERATURE DEPENDENCE OF THE VORTEX-CORE PARAMETER IN He II. Steingart, M.; Glaberson, W. I. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., A; 5: No. 2, 985-6(Feb 1972).

The theoretical vortex-core radii of Pollock are shown to be in gross disagreement with recent experimental results of Glaberson and Steingart. (auth)

24024 THERMALLY ASSISTED ESCAPE OF IONS FROM VORTICES IN He II. Padmore, Timothy C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 28: No. 8, 469-72(21 Feb 1972).

The theory of ion escape from vortices in helium is re-examined with the introduction of non-Markoffian features of the ion–vortex interaction. After several physically motivated approximations, the present theory takes the form of earlier theories except that the hydrodynamic potential is replaced by an effective potential depending on the ion mobility. A conflict with experiment is thereby resolved, and one can proceed to use escape data to investigate the vortex core structure. (auth)

24025 STOCHASTIC THEORY OF THE NUCLEATION OF QUANTIZED VORTICES IN SUPERFLUID HELIUM. Donnelly, R. J.; Roberts, P. H. (Univ. of Oregon, Eugene). Phil. Trans. Roy. Soc. London, Ser. A; 271: No. 1212, 41-100(23 Dec 1971).

The problem of the appearance of quantized vortex lines and rings in superflow, and the modification of that flow by the vortices are examined in the light of a suggestion by Iordanskii(1965), namely that thermal fluctuations may play a vital role in the nucleation process. The view is taken that there exists a distribution of quantized vortex rings in liquid helium and that the smallest of these is a roton. The evolution of these rings in a counterflow is examined by means of a Langevin equation. A Fokker–Planck equation is developed, and a number of examples are presented that illustrate the features of such processes. These include nucleation of vortices in an unbounded fluid, nucleation in a finite channel, the thermally activated vortex mill, nucleation of vortices by ions and phonon-roton relaxation times. (auth)

24026 EFFECT OF HEAT CURRENT MODULATION ON VELOCITY FIELDS AND CRITICAL REYNOLDS NUMBER IN HELIUM II. Oberly, Charles Evan. Columbus, Ohio; Ohio State Univ. (1971). 257p. University Microfilms Order No. 72-4597.

Thesis.

A series of experiments was conducted to determine whether the flow instability leading to turbulence in the normal component of helium II can be stabilized by modulating the flow, as is observed in classical fluid flow. Stabilization of laminar normal fluid flow in helium II beyond the usual critical Reynolds number was observed in these experiments. The experiments demonstrated that helium II flow can be stabilized with viscous wave modulation, and that the stabilization of the normal fluid is analogous to classical fluids such as water. The onset of the superfluid turbulence is clearly signaled before that of the normal fluid and is found to be frequency-dependent for modulated flow. Hydrodynamical scaling was demonstrated using the helium II two-fluid model. As a result of the viscous wave stabilization measurements, a new dimensionless parameter P was formulated which better characterizes the onset of normal fluid turbulence in helium II. The classical Reynolds number has not been at all satisfactory for describing the onset of normal fluid turbulence, especially above 1.5°K. Additional temperature dependence of P allows the removal of most of the discrepancy in the description of the onset of normal turbulence for steady state flow at higher temperatures. Analysis of all relevant published data, as well as the data of this experiment, results in a more nearly constant critical parameter P throughout the temperature range of hydrodynamic flow in helium H. (TSS) (Diss. Abstr. Int., B)

24027 COLLISION TIMES AND KINETIC THEORY FOR SUPERFLUID HELIUM. Saslow, Wayne M. (Univ. of Pittsburgh). Phys. Rev., A; 5: No. 3, 1491-1502(Mar 1972).

It was found that the low-temperature collision-time kinetic theories of Khalatnikov and Chernikova and of Disatnik are not in agreement with all of the predictions of superfluid hydrodynamics. In particular, they overestimate, by a factor of about 30, the attenuation of hydrodynamic first sound. In addition, they use a hydrodynamic collision time to describe both the hydrodynamic and collisionless regimes, causing disagreement with many-body calculations valid for the collisionless regime. A kinetic theory is constructed which is in agreement with superfluid hydrodynamics, and the existing kinetic theories are analyzed in order to find the origins of the disagreement with hydrodynamics and with the many-body theory. To obtain correct transport coefficients (and therefore correct attenuation of hydrodynamic first sound) it is found necessary to ensure that the system relaxes to local, rather than to static, equilibrium. The transport coefficients are calculated within a collision-time model, and it is pointed out that for generality one must employ two hydrodynamic collision times τ_1 and τ_t (with $\tau_1 \geq \tau_t$) associated with longitudinal and transverse processes, respectively. From this it is shown that ζ_2 is not necessarily equal to zero. In addition, difficulties involved in extending the theory to higher frequencies are discussed, and a physical argument is presented that requires the use of a wide-angle collision time to define the (low-frequency) hydrodynamic regime and a small-angle collision time to define the (high-frequency) collisionless regime. This reconciles the disagreement between kinetic theory and many-body calculations upon the collision time which defines the collisionless regime. Various experiments are interpreted on this basis, thereby eliminating certain discrepancies with theory. Measurements in the low-temperature hydrodynamic regime are shown to require relatively large chambers (with linear dimensions $\gtrsim 10$ cm). (auth)

24028 BOSE–EINSTEIN CONDENSATION IN THIN FILMS. Pathria, R. K. (Univ. of Waterloo, Ont.). Phys. Rev., A; 5: No. 3, 1451-6(Mar 1972).

An asymptotic evaluation of the specific heat of an ideal Bose gas confined to thin-film geometry ($\infty \times \infty \times D$) is carried out, under a variety of boundary conditions, without converting sum-

mations into integrations. The theoretical results for the Dirichlet boundary conditions ($\psi_s = 0$) contain all the significant features of the numerical results obtained earlier by Goble and Trainor; in particular, the characteristic length D^* at which the specific heat of the system is at an absolute maximum is reproduced. It turns out that D^* is directly proportional to the mean interparticle distance $\bar{l}$, with a constant of proportionality $c(\approx 20\text{-}30)$. No such characteristic length appears if boundary conditions other than Dirichlet's are employed. The shift, and the rounding off, of the specific-heat maximum are also studied, and the distinguishing influence of the boundary conditions examined. (auth)

24029 NEUTRON SCATTERING BY ROTONS IN LIQUID HELIUM. Dietrich, O. W. (Danish Atomic Energy Commission, Risoe); Graf, E. H.; Huang, C. H.; Passell, L. Phys. Rev., A; 5: No. 3, 1377-91(Mar 1972).

The elementary excitations in superfluid helium were studied in the wave-vector range $1.5 < Q < 2.3$ Å^{-1} by inelastic neutron scattering. The single-excitation scattering function $S_1(Q, \hbar\omega)$ was measured for pressures between 1 atm and the solidification pressure and for temperatures from 1.3°K to above the transition temperature T_λ. The dispersion curves were fitted to parabolas and the appropriate Landau parameters tabulated vs temperature and pressure. By accounting for the effect of the instrumental resolution it was possible to observe a line broadening at low temperatures which sets in when the slope of the dispersion curve equals the sound velocity. There are strong indications that this is due to the roton–phonon interaction proposed by Pitaevskii. The line broadening observed when the temperature approaches T_λ is well accounted for by the roton–roton interaction as calculated by Landau and Khalatnikov. The results were related through thermodynamics to other properties of the liquid and the spectral form of the excitations compared to those observed in magnetic systems close to the critical temperature. (auth)

24030 HIGH-HEAT-FLUX REGIME OF SUPERFLUID COOLING IN VERTICAL CHANNELS. Eaton III, Russell; Lee, William D.; Agee, Forrest J. Jr. (Army Mobility Equipment Research and Development Center, Fort Belvoir, Va.). Phys. Rev., A; 5: No. 3, 1342-9(Mar 1972).

Limiting temperature gradients at the breakdown of superfluid heat transport were measured as a function of temperature for three configurations of insulated vertical channels. Values of the temperature gradient calculated from a vaporization hypothesis are in good agreement with the experimentally measured gradients, indicating that metastable superheating does not occur. Systematic discrepancies noted at low temperatures and high heat fluxes show that the vaporization hypothesis is not a complete description. Values of the Gorter–Mellink constant were determined and are found to exhibit a systematic dependence on channel size as well as temperature. Limiting heat fluxes calculated using the experimentally determined Gorter–Mellink constant are in good agreement with experimental values above ~1.6 K; deviations are observed at lower temperatures. (auth)

24031 PERTURBATION THEORY BASED ON CURRENTS FOR INTERACTING BOSONS AT ABSOLUTE ZERO. Chang, B. Tsu-shen (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 5: No. 3, 1480-90(Mar 1972).

As a continuation of a recent paper, using density and current density as coordinates for interacting bosons at absolute zero, this work deals with the perturbation theory. The zeroth-order Hamiltonian is the one shown to yield the Bogolyubov energy spectrum. First- or second-order perturbation calculations were made of the three-phonon and the four-phonon vertices for the energy corrections of the low-lying excited states. The results in the long-wavelength limit differ, although only slightly, from the quantum hydrodynamic calculations, and indicate that the perturbed excitation energy ϵ_k^* is an odd-power series in k if the Fourier coefficients of the two-body potential concerned can be approximated by a constant or an even-power series in k. However, whether this remains so in all higher orders of various perturbations is an open question. Two methods were used in the calculation. The first involves functional representations of the coordinates in the ρ_k^* representation recently reported. The second method is new, and employs occupation-number representations of the current algebra by introducing creation and annihilation operators for phonons from density fluctuations. These latter representations enable us to benefit from the advantages of the canonical field theory. (auth)

24032 EXCITATION OF SOUND IN A FERMI–BOSE LIQUID. Semiz, D. M. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 371-3(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 538-40(5 Nov 1971).

The problem of excitation of sound in a solution by oscillations of a plane boundary is considered, and the ratio of the values of the radiated energy fluxes of first and second sound is found. The ratio obtained is of the order of 10^{-3} at ~1% He^3 concentration, making it possible to hope to observe second sound experimentally in a solution when excited by the indicated method. (M.H.R.)

24033 CORRECTIONS TO THE IMPULSE APPROXIMATION FOR HIGH-ENERGY NEUTRON SCATTERING FROM LIQUID HELIUM. Gersch, H. A.; Rodriguez, L. J.; Smith, Phil N. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 5: No. 3, 1547-58 (Mar 1972).

Corrections to the impulse approximation for scattering from a many-body system are derived in the form of a series in inverse powers of the momentum transfer k. The coefficients in this series are written in terms of the two-body interaction potential and the particle-density matrices. Application is made to the case of high-energy neutron scattering from liquid helium. Evaluation of correction terms corresponding to a single helium–helium collision during the neutron–helium interaction time indicates (a) a shift in the peak of the incoherent-scattering cross section toward lower energy by a constant amount, and (b) an asymmetry of the cross section with respect to neutron energy loss about its peak value. Numerical estimates are given for these two effects for k = 14.3 Å^{-1}. Evaluation of condensate broadening due to multiple He–He collisions shows that the condensate-scattering contribution has a width proportional to $k^{\frac{1}{2}}$, and is thus distinguishable from the main noncondensate peak whose width is proportional to k. Estimates are given for requirements on experimental-resolution functions necessary to preserve this evidence of a distinct condensate contribution. (auth)

24034 THERMODYNAMIC RELATIONSHIPS AT THE TRICRITICAL POINT IN ^{3}He–^{4}He MIXTURES. Rice, O. K.; Chang, Do-ren (Univ. of North Carolina, Chapel Hill). Phys. Rev., A; 5: No. 3, 1419-22(Mar 1972).

An analysis is made of the λ transition, the phase-separation transition, and the relation between the two, for mixtures of liquid ^{3}He and ^{4}He. Stability conditions require that C_x (specific heat at constant x, where x is the mole fraction ratio x_4/x_3 of ^{4}He to ^{3}He) be less than a certain value, or, equivalently, that $(\partial\mu_4/\partial x)_T$ be positive (μ_4 is the chemical potential of ^{4}He). The phase separation occurs when these conditions are violated. The changes in these quantities appear to occur gradually rather than suddenly, as supposed earlier by one of us. The evidence indicates that there is no real critical singularity at the tricritical point. It then seems reasonable to expand thermodynamic functions about each side of the tricritical point separately, and by thermodynamic arguments the relations between the critical exponents β (for the coexistence curve) and δ (for the critical isotherm) can be obtained and compared with observations. (auth)

24035 PRESSURE–DENSITY–TEMPERATURE RELATIONS OF ^{3}He–^{4}He MIXTURES NEAR THE LIQUID–VAPOR CRITICAL POINT. Wallace, Barnie Jr.; Meyer, Horst (Duke Univ., Durham, N. C.). Phys. Rev., A; 5: No. 2, 953-64(Feb 1972).

Measurements of the density ρ versus pressure P along isotherms for six ^{3}He–^{4}He solutions ($X_3 = 0.960, 0.886, 0.800, 0.600, 0.400$, and 0.200) near their liquid–vapor critical point are presented. For a given mole fraction X_3, it was found that the boiling and dew curves in the ρ–P plane could be represented by a relation similar to that for the coexistence curve of a pure fluid. Here the point at the extremity of the two-phase region, which we call symmetry point with the parameters P_s, ρ_s, and T_s, takes the place of the critical point for a pure fluid. The dew curve is given by $(\rho_s - \rho) \propto (P_s - P)^{\beta'}$ with $\beta' = 0.375 \pm 0.02$, independent of X_3. The determination of the line of critical points in the P–T plane from the dew and boiling curves at various mole fractions is described. The pressure, density, and temperature for the critical and the symmetry points are presented and discussed. From the dew and boiling curves, the true coexistence curves were constructed in the ρ–P plane at constant T and in the ρ–T plane at constant P and could be described approximately by $(\rho_L - \rho_G) \propto (P_c - P)^{\beta_T}$ and $(\rho_L - \rho_G) \propto (T - T_c)^{\beta_P}$ with an average value for the various isotherms and isobars considered of $\beta_T = 0.42 \pm 0.06$ and $\beta_P = 0.39 \pm 0.05$. Here ρ_L and ρ_G are the densities along the coexistence curve on the liquid and the gas side, respectively. The measurements of the compressibility $k_{T,X}$ along the critical isochore in the one-phase region seem to exclude a strong divergence with $(T - T_c)$, but do not extend close enough to T_c to either support or disprove the weak divergence as predicted by Griffiths and Wheeler. These measurements are compared with those of the normalized compressibility $(\rho/\rho_s)^2 k_{T,X}$ along the dew and boiling curves. Comparisons are also made with the behavior of the compressibility for a pure fluid along the coexistence curve and above T_c. A brief addendum to the analysis for k_T in pure ^{3}He is presented. (auth)

24036 EXCITATION SPECTRUM OF LIQUID HELIUM BY SMALL-ANGLE SCATTERING OF NUCLEAR GAMMA RAYS. Fox, Raymond (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., A; 5: No. 2, 923-7(Feb 1972).

Considerable difficulty was evidenced recently in determining and understanding the excitations in liquid helium and their interactions. Small-angle scattering of nuclear gamma rays is suggested for studying the excitations, which should complement the investigations using inelastic neutron scattering. The theory is presented and experimental problems are discussed. The differential cross section for small-angle scattering of nuclear gamma rays for single excitations is related to the x-ray liquid structure factor. The shift in energy of the nuclear gamma rays is expressed in terms of a Doppler shift which is shown to be comparable to the velocities used in nuclear resonance fluorescence. Scattering angles, linewidths, count rates, and resolution are evaluated. (auth)

24037 INTRINSIC CRITICAL VELOCITIES IN SUPERFLUID HELIUM. Langer, J. S. (Carnegie-Mellon Univ., Pittsburgh); Reppy, J. D. Progr. Low Temp. Phys.; 6: 1-35(1970).

The basic assumptions of a nonequilibrium theory of superflow is presented in as general a manner as possible. A survey of relevant experimental results is presented. Several attempts to compare the experimental data to more specific models of the fluctuations that may occur in a superfluid are described. (16 figs., 32 references). (M.H.R.)

24038 THIRD SOUND. Atkins, K. R. (Univ. of Pennsylvania, Philadelphia); Rudnick, I. Progr. Low Temp. Phys.; 6: 37-76(1970).

The following topics are covered: historical survey, the theory of third sound on thick films, experimental results for thick films, third sound on moving film; theory of third sound on very thin films, experimental results for very thin films, the average superfluid density, the onset thicknesses, and attenuation. (22 figs., 52 references) (M.H.R.)

24039 EXPERIMENTAL PROPERTIES OF PURE ^{3}He AND DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He AT VERY LOW TEMPERATURES. APPLICATION TO DILUTION REFRIGERATION. Wheatley, John C. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-34-P. A. 143. Progr. Low Temp. Phys.; 6: 77-161(1970).

Progress made in experimental knowledge at very low temperatures of the properties of pure ^{3}He, dilute solutions of ^{3}He in superfluid ^{4}He, and dilution refrigeration is reviewed. The intrinsic limitations of dilution refrigeration and the use of dilution refrigerators below approximately 10 mK are discussed. (11 tables, 37 figs., 147 references). (M.H.R.)

24040 Λ-POINT MEASUREMENTS OF $\eta\rho_n$ FOR PURE ^{4}He AND FOR THREE ^{3}He–^{4}He MIXTURES. Webeler, R. W. H.; Allen, G. (Lewis Research Center, Cleveland). Phys. Rev., A; 5: No. 4, 1820-7(Apr 1972).

Torsional crystal measurements of $\eta\rho_n$ were made for pure ^{4}He and for three ^{3}He–^{4}He mixtures (x_3 = 0.005, 0.047, and 0.100) over temperature intervals which included their respective λ points. The precision of the measurements for the mixtures was greater than that of any previous λ-point $\eta\rho_n$ measurements. Doubly reduced plots of $\eta\rho_n$ versus T showed a slight but definite tendency for such curves to rotate clockwise about the (1, 1) point with increasing x_3 up to about 0.05. Values of η were derived from the measurements by computing ρ_n as a function of T*. For each mixture, both η and $d\eta/dT$ were continuous across $T_\lambda(x_3)$. No tendency was manifest for such curves to develop discontinuities as x_3 decreased. It was, therefore, inferred that both η and $d\eta/dT$ of pure ^{4}He are continuous across $T_\lambda(0)$. A further result obtained here is that, up to x_3 = 0.100, the λ viscosity of the mixture $\eta_\lambda(x_3)$ bears a linear relationship to the λ temperature of $T_\lambda(x_3)$. (auth)

24041 ^{3}He DIFFUSION IN LIQUID ISOTOPIC MIXTURES. Harrison, R. B.; Hatton, J. (Oxford Univ.). J. Low Temp. Phys.; 6: No. 1-2, 43-50(Jan 1972).

Spin-echo techniques were used to study the diffusion of ^{3}He in liquid isotopic mixtures with molar concentrations in the range from X_3 = 0.137 to 0.850 over a temperature range from ~3.0 to ~0.4 K. Above T_λ the diffusive behavior is very similar to that of pure ^{3}He, although there is an increased scattering associated with ^{4}He. Below T_λ the diffusion coefficient increases with decreasing temperature and shows a dependence on the ^{3}He number density much like that of a classical gas. The excitations of ^{4}He have little influence on the ^{3}He diffusion coefficient, even at temperatures well above 1 K. (auth)

24042 SCALING PARAMETER FOR He II THERMAL COUNTERFLOW AND CRITICAL HEAT CURRENTS. Tough, J. T.; Oberly, C. E. (Ohio State Univ., Columbus). J. Low Temp. Phys.; 6: No. 1-2, 161-70(Jan 1972).

A scaling parameter for He II thermal counterflow is developed from a consideration of the stability of the normal-fluid component in the presence of superfluid vortex production. Observations of superfluid "entrainment" are combined with a reinterpretation of the "mutual friction force" to define the scaling parameter which is shown to be independent of temperature and geometry at the critical heat current. (auth)

24043 TEMPERATURE FLUCTUATIONS ASSOCIATED WITH GRAVITY WAVES AT A VAPOR/SUPERFLUID INTERFACE. Halley, J. Woods (Univ. of Minnesota, Minneapolis). Phys. Rev., A; 5: No. 4, 1807-12(Apr 1972).

The existence of temperature oscillations associated with surface gravity waves is shown for an incompressible superfluid in the two-fluid model in equilibrium with its compressible vapor. The properties of the oscillations are consistent with some informally reported observations. (auth)

24044 LIQUID HELIUM AND THE PROPERTIES OF A BOSE–EINSTEIN GAS. IV. THE EFFECT OF VARIOUS APPROXIMATIONS. Goble, D. F. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Phys.; 49: No. 24, 3099-3114(15 Dec 1971).

On a qualitative basis the identification of the properties of a hard-core Bose—Einstein (BE) gas with those of liquid helium four below the lambda temperature was examined. It is suggested that the use of the generalized condensation of Girardeau together with the inclusion of three-body ladders from the perturbation series may improve the agreement between the hard-core BE model system and the physical helium four system to such an extent that reasonable quantitative agreement may be attained. (auth)

24045 SURFACE PHENOMENA IN A SUPERFLUID LIQUID. Andreev, A. F.; Kompaneets, D. A. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2459-74(Dec 1971). (In Russian).

Surface elementary excitations in a superfluid liquid form a surface normal part whose movement along the surface is accompanied by transfer of mass, energy, entropy, etc. In this connection, the boundary conditions at the free surface for the volume two-velocity hydrodynamics equations are given by the set of surface hydrodynamic equations of motion. The surface normal density and surface thermodynamic quantities and in particular the surface tension depend on the relative velocities of the normal and superfluid components. The surface dissipative function is calculated. The surface oscillation spectrum is investigated at low temperatures. Besides capillary waves, there exists a surface second sound. In pure ^{4}He, its velocity is proportional to the cube root of temperature. In the presence of very small amounts of ^{3}He impurities, the velocity at first decreases as $T^{\frac{1}{2}}$ on lowering of the temperature, passes through a minimum, and at zero temperature reaches a value of the order of the velocity of first sound in the liquid volume. (auth)

24046 SOME MEASUREMENTS IN LIQUID HELIUM FOUR. Goldschvartz, Jacobo Meyer. Delft, Netherlands; Technische Hogeschool (1971). 184p.

Thesis.

The papers published in the last five years on different subjects about liquid ^{4}He form the basis of this work. First a brief resumé of liquid ^{4}He is presented. Some new materials for superleaks and a new method for measuring the onset point of a superleak are described. The apparatus and instrumentation for measuring the electrical breakdown of liquid helium are described. Five published papers on this subject containing all the measurements performed during the last eight years are included. Existing theories on the electrical breakdown of liquid dielectrics are discussed as well. A new method of measuring ionic mobilities in liquid dielectrics in high electric fields and the classical method are described. Two published papers with results are included. A modified helium Dewar is described. General discussions for the chapters containing criticisms and plans for future work on each of the subjects are included. (M.H.R.)

24047 SOLID PHASE OF ^{4}He MONOLAYERS: DEBYE TEMPERATURES AND MELTING ANOMALIES. Bretz, M.; Huff, G. B.; Dash, J. G. (Univ. of Washington, Seattle). Phys. Rev. Lett.; 28: No. 12, 729-31(20 Mar 1972).

Specific heats of ^{4}He monolayers on graphite indicate two-dimensional solid phases. Debye temperatures Θ range from 17.6° to 56° systematically with coverage. Anomalies are identified with melting, but the melting process is a continuous transition. Films and bulk solid ^{4}He at equal values of interatomic spacing have nearly the same Θ's and melting temperatures. (auth)

Superconductivity

Refer also to abstracts 22939, 23288, 24688, and 24695.

24048 (AD-732241) HIGH-TEMPERATURE SUPERCONDUCTORS: AN EMPIRICAL APPROACH TO SUPERCONDUCTIVITY. Final Report. Matthias, Bernd T. (California Univ., San Diego. Dept. of Physics). 14 Oct 1971. 22p. (AFOSR-TR-71-2324). NTIS.

The superconducting transition temperature was raised to 21°K, the critical magnetic field to 415 kG. Twelve new superconducting elements were discovered, one third of all those known. Ferroelectricity and lattice instabilities were found as a major obstacle to much higher transition temperatures. Two entirely new groups of superconducting compounds were discovered. F-electron superconductivity was detected, making lanthanum superconducting above 12°K, the highest of all elements. Two new theories were published. (USGRDR)

24049 (DESY-71/57) INDIRECT COOLING OF SUPERCONDUCTING Nb-Ti INTRINSICALLY STABILIZED MAGNET COILS. Eschricht, W.; Fiebig, H. J.; Horlitz, G.; Knopf, U.; Knust, G.; Nowakowski, K. D.; Peters, O.; Stahlschmidt, W.; Wolff, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. 28p. Dep. NTIS (U. S. Sales Only).

A simple method of indirect cooling of superconducting coils is described. Intrinsically stabilized conductors were successfully operated while being cooled by heat conduction over a distance of twenty-six centimeters between conductor and heat exchanger. (auth)

24050 (NYO-4060-10) STUDY OF THE INTERACTION BETWEEN MAGNETIC FLUXOIDS AND CRYSTAL DEFECTS IN TYPE II SUPERCONDUCTORS. Progress Report. Kramer, Edward J. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 31 Oct 1971. Contract AT(30-1)-4060. 32p. Dep. NTIS.

An experimental program to characterize the surface contribution to the critical current in niobium was continued. An exhaustive experimental study of the hysteresis in a 1% deformed triangular niobium crystal was completed. The current status of the theoretical models is mentioned briefly. (M.H.R.)

24051 LATTICE INSTABILITIES AND SUPERCONDUCTIVITY OF (Hf,Ta)V_2 AND (Hf,Zr)V_2 ALLOYS. Lawson, A. C. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 38A: No. 6, 379-80 (13 Mar 1972).

Superconducting transition temperatures are correlated with lattice instabilities in the pseudobinary alloys (Hf, Ta) V_2 and (Hf, Zr) V_2. (auth)

24052 QUANTUM-FLUCTUATION-INDUCED DIAMAGNETIZATION IN A SUPERCONDUCTOR. Fibich, M.; Revzen, M. (Israel Inst. of Tech., Haifa). Phys. Lett.; 38A: No. 6, 385-6(13 Mar 1972).

An expression for the free energy in a superconductor used to calculate the fluctuation-induced diamagnetism is derived from a quantum theory of fluctuations. (auth)

24053 UNDAMPED COOPER PAIRS IN A NONDEGENERATE ELECTRON SYSTEM. Kumar, N.; Nandini, R. (Indian Inst. of Science, Bangalore). Phys. Lett.; 38A: No. 6, 425-6(13 Mar 1972).

Following the reaction matrix technique and the Kanamori approximation, a condition is obtained for the occurrence of undamped Copper pairs in a nondegenerate electron system. Its relevance to induced superconductivity in systems with artificially populated (optically pumped) bands is pointed out. (auth)

24054 HALL EFFECT IN THE MIXED STATE OF INTRINSIC TYPE-II-SUPERCONDUCTOR In_5Bi_3. Hering, E.; Cruceanu, E. (Max Planck Institut fuer Metalliforschung, Stuttgart). Phys. Lett.; 38A: No. 6, 431-2(13 Mar 1972).

The Hall angle was observed in the mixed state of the intrinsic superconductor In_5Bi_3. Its field dependence shows a behavior changing the sign by entering into the mixed state and in the mixed state itself. The dependence of the true Hall effect on the angle φ between the surface normal and external magnetic field shows an anisotropy of crystallographic origin. (auth)

24055 X-RAY PHOTOELECTRON SPECTROSCOPIC STUDIES OF NIOBIUM CONTAINING INTERMETALLIC COMPOUNDS. Novakov, T. (Shell Development Co., Emeryville, Calif.); Geballe, T. H. Solid State Commun.; 10: No. 2, 225-9(15 Jan 1972).

The chemical shift of the $3d_{\frac{5}{2}}$ core level of Nb in the series of rock salt and beta-tungsten structures was measured. In the rock salt series, the superconductivity and charge transfer are correlated, although not enough samples were studied to give convincing evidence. The growth of oxide on the surface of niobium metal and its effect on the Nb $3d_{\frac{5}{2}}$ level were investigated. (auth)

24056 MECHANICAL AND SUPERCONDUCTING PROPERTIES OF ALLOYS IN THE NIOBIUM-TITANIUM SYSTEM AND AREA OF THEIR APPLICATION. Baikov, A. I.; Kuznetsova, M. I.; Mel'nikova, L. V. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 98-110(1971). (In Russian).

Alloys in the system Nb-Ti with contents of Ti > 40 at. % have higher critical magnetic field than the alloys Nb-Zr and Nb-Ti-Zr. The highest magnetic field is produced in the alloy with 60 at. % Ti. A wire of this 60 T alloy was used in the manufacturing of superconducting solenoids. (JPRS)

24057 EFFECTIVE VISCOSITY OF DILUTE SOLUTIONS OF LIQUID ^{3}He IN ^{4}He BETWEEN 20 mK AND 1 K. Bertinat, M. P.; Betts, D. S.; Brewer, D. F.; Butterworth, G. J. (Univ. of Sussex, Eng.). Phys. Rev. Lett.; 28: No. 8, 472-4(21 Feb 1972).

Detailed measurements were made of the effective viscosity of dilute ^{3}He-^{4}He solutions between 20 mK and 1 K, by observation of the damping of torsional oscillations of a quartz crystal. The results are strikingly different, in magnitude and in temperature dependence, from theoretical predictions and from previous preliminary results. (auth)

24058 CURRENTS IN ROUGH SURFACES OF TYPE II SUPERCONDUCTORS. Melville, P. H. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., C (London); 5: No. 2, 147-58(31 Jan 1972).

At various times four principal mechanisms have been suggested to explain surface currents in Type-II superconductors in fields between H_{c1} and H_{c2}. These are: Meissner currents, the surface sheath, the surface barrier, and flux pinning. Any surface produced for large-scale practical application will be very much rougher than the London penetration depth and, consequently, effects due to the surface sheath and the surface barrier should be small. The combination of Meissner currents and flux pinning has already been considered in connection with ac loss in the Meissner state (Melville, J. Phys. C. 4: 2833(1971)). Here the calculations are extended to fields above H_{c1} and compared with experiments on niobium and niobium-titanium foils. There is good agreement over most of the field range. If, as is the case in most practical circumstances, interest is in the change in flux density between the outside and inside of the superconductor, the greatest contribution is from the Meissner currents, with flux pinning in the region of surface roughness giving secondary effects. (auth)

24059 STUDIES OF THE ALTERNATING CURRENT JOSEPHSON EFFECT. Russer, P. (Technische Hochschule, Vienna). Acta. Phys. Austr.; 32: No. 3-4, 373-81(Mar 1970). (In German).

The current-voltage characteristics of Josephson junctions were studied in a microwave field. Measurements were performed at 4.2°K with a coaxial resonator possessing niobium point junctions. Theoretical studies were conducted with an analog model. (tr-auth)

24060 THERMAL CONDUCTANCES AT A TYPE-II SUPERCONDUCTOR/NORMAL METAL INTERFACE. Chang, Yu-wen. Los Angeles; Univ. of California (1971). 161p. University Microfilms Order No. 72-2786.

Thesis.

Thermal conductances at the Type-II superconductor-normal metal interfaces were measured with the heat flow normal to the interfaces. The Nb/Cu junctions (samples Nb/Cu I and Nb/Cu II) were manufactured by casting Cu onto Nb cylinders. The NbTi/Cu sample was a slab cut from a rod of Nb-48 wt % Ti composite. Micro-probe measurements showed Nb/Cu I, Nb/Cu II, and NbTi/Cu with junction thicknesses of 4, 2, and 5 μ, respectively. The samples were placed inside a superconductor solenoid with the solenoid axis perpendicular to the Nb/Cu and parallel to the NbTi/Cu junctions. The conductances were found to be related to the junction thicknesses and the purity of the superconductors. Measurements between 1.4 and 5°K showed that the normal-state conductances (h_n) were larger than the superconducting-state values (h_s), and that h_s of Nb/Cu II stayed nearly constant between 2 and 3°K. Possible large phonon contributions to h_n of Nb/Cu samples were observed, although results of the normal-state Nb thermal conductivities indicated that thermal energy was carried to the junctions mainly by electrons. The h_s of NbTi/Cu was independent of a constant field up to at least 30 KOe at 2°K and 10 KOe at 5°K. Large changes in h_s could be observed with the field driven at a constant speed. No significant differences could be detected between the conductances measured with the heat flow from Cu into NbTi and from NbTi into Cu. The mixed-state conductances h_m of Nb/Cu II were found changing slightly with field until the field reached H_p, larger than the lower critical field H_{c1}

of Nb. This indicated a delayed flux entry into the sample. Beyond H_p, a small decrease in conductances similar to phonon dip in the mixed-state Nb thermal conductivity occurred at low temperatures. Subsequently, h_m increased toward h_n near the field H_U smaller than the upper critical field H_{c2} of Nb. Flux trapping was observed upon field reversal. Regularly spaced large thermal spikes (flux jumps) were visible with all samples in fields swept at a constant speed. In decreasing fields, the combined effects of magnetothermal heating and flux jumps in the low-field region produced large temperature excursions of about 3°K in the sample NbTi/Cu. The thermometers at the Cu side of the junctions sensed the flux jumps patterns of the superconductors. Modulated low frequency temperature oscillations at the Cu side of the Nb/Cu II junction were observed even at fields beyond H_{c2} of Nb. The inclusion of many small Nb/Cu globules within the Cu near the Nb/Cu II junction may be related to these oscillations. Numerical calculations show that, near the transition temperature of a superconductor, electrons tunneling from a BCS superconductor into a normal metal give a larger thermal conductance than electrons tunneling with the superconductor in the normal state. (Diss. Abstr. Int., B)

24061 NONLINEAR FLUX FLOW RESISTIVITY IN SUPERCONDUCTING TIN FILMS. Payne, James Edward. Clemson, S. C.; Clemson Univ. (1971). 87p. University Microfilms Order No. 72-5040.

Thesis.

Previous investigations of the flux flow resistance state in both bulk and thin film superconductors were concerned with the description of a linear flux flow resistivity. This work describes the nonlinear current–voltage characteristics of thin films in a perpendicular magnetic field over a wide range of thicknesses and temperatures. The samples were deposited on glass substrates at either room temperature or liquid nitrogen temperature. The films varied in thickness from 180A (18 nm) to 3020A (302 nm) and were examined at temperature ratios from 1.0 to 0.5. A theoretical model in which the area of the fluxon core increases with transport current gives results of the type observed experimentally. The agreement between the model and the experiment is excellent except in the case of applied magnetic fields near the critical field. In this region the agreement is only qualitative. It is felt that the model fails here because it assumes a uniform transport current density, an assumption which is invalid when the normal cores are close together. (Diss. Abstr. Int., B)

24062 STUDY OF FLUX TRAPPING IN SUPERCONDUCTING TIN–INDIUM. Ghalia, Manjula Damji. Norman, Okla.; Univ. of Oklahoma (1971). 95p. University Microfilms Order No. 72-3391.

Thesis.

The reduced surface resistance r of superconducting lead at 12 GHz was determined from measurements of the Q of a high-Q superconducting lead plated cavity resonant in the TE_{011} mode. Q's as high as 196.5×10^6 were obtained. The results are compared to r_{AGK}, the theoretical surface resistance derived by Abrikosov, Gor'kov and Khalatnikov. It is found that $r = 7.326\ r_{AGK} + 0.0002826$, using the value of $1.97\ k_BT_c$ for the energy gap parameter at 0°K. Also, r obeys the Pippard temperature dependence, P(t), with $r = 0.0971\ P(t) - 0.0001795$. The cavity is used to study the flux-trapping in Sn–In with one of its end plates replaced by a sample of Sn–In. In the presence of flux trapping, the surface resistance of 4 and 5% In–Sn (annealed for 24 hours at 200°C) follows the Pippard temperature dependence. By applying the magnetic field both before and after the lead cavity walls become superconducting, it is possible to estimate A_0, the area that traps flux in the Sn–In sample at its transition into the superconducting state. The residual losses due to flux-trapping are found to be proportional to the applied magnetic field. Flux-trapping in these samples is found to be structure-sensitive rather than impurity-sensitive. Measurements on a laboratory-made 13% In–Sn sample confirmed the structure sensitivity of flux trapping in a lightly annealed sample. Measurements were also made on a laboratory-made 3% In–Sn alloy as a function of annealing time, starting with the cold-rolled alloy. The Pippard temperature dependence is observed. For a cold-rolled sample, the low critical field regions that trap flux are shown to decrease in area exponentially with the constant-temperature annealing time. (Diss. Abstr. Int., B)

24063 STUDY OF SUPERCONDUCTING MOLYBDENUM. Waleh, Ahmad. Baton Rouge, La.; Louisiana State Univ. (1971). 86p. University Microfilms Order No. 72-3531.

Thesis.

The thermodynamic critical field and associated supercooling field in superconducting molybdenum were measured and analyzed. The zero-field transition temperature and the zero-temperature critical field are found to be $T_c = 0.903 \pm 0.003$°K and $H_c(0) = 96 \pm 2$ G, respectively. The coexistence of a superconducting surface sheath with a supercooled normal bulk is confirmed. Assuming a temperature dependence of the Ginzburg–Landau parameter $\varkappa$ of molybdenum, similar to that of Type-II superconductors, it is found that only when $\varkappa < \varkappa_c = 0.375$, is the supercooling field identical with the surface nucleation field. When $\varkappa > \varkappa_c$, a superconducting surface sheath coexists with a supercooled bulk and the supercooling field is no longer the same as the surface nucleation field. The thermal conductivity measurements on molybdenum, in both the superconducting and normal states, are analyzed. A quantitative comparison with the theory of BRT yields energy-gap values of $2\epsilon(0) = 3.4 \pm 0.1$, close to T_c, and $2\epsilon(0) = 3.2 \pm 0.1$ at lower temperatures. The discrepancy of the results is discussed in terms of the anisotropy of the energy gap in molybdenum and also in terms of possible sd-interband scattering. Equivalently, the results are discussed in terms of both an isotropic one-band model and an overlapping spherical two-band model for superconductivity. (Diss. Abstr. Int., B)

24064 SPECIFIC HEAT OF SUPERCONDUCTING TRANSITION METALS CONTAINING NONMAGNETIC IMPURITIES AT LOW TEMPERATURES. Burkel, Richard Henry. Cincinnati; Univ. of Cincinnati (1971). 85p. University Microfilms Order No. 72-4321.

Thesis.

Green's function theory is used for calculation of the specific heat of superconducting transition metals containing nonmagnetic impurities at low temperatures, $T \to 0$. It is found that, to a good approximation in this temperature region, the s-band specific heat is lowered by the presence of the nonmagnetic impurities. The logarithm of the s-band specific heat obeys the following relation: $\ln C_s = \ln C_s^{(0)} - /k_BT$ for $T \to 0$, where $C_s^{(0)}$ is the s-band specific heat for a pure two-band superconductor, and is proportional to the density of impurities, the density of states at the d = band Fermi surface, and the strength of the interband impurity scattering. A numerical calculation is performed with a more accurate relation, and the value of several parameters is found by fitting the experimental data of Shen, Senozan, and Phillips. (Diss. Abstr. Int., B)

24065 SUPERCONDUCTING TRANSITION TEMPERATURE OF A METASTABLE MIXTURE BASED ON NONTRANSITION METALS. Orlov, A. F. (Inst. of Metallurgy, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 339-41(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 496-8(5 Nov 1971).

The change of T_c was investigated in metastable solid solutions with varying compositions of the systems Al–Ag, Al–Sn, and In–Bi, obtained by simultaneous condensation of the components on a substrate cooled with liquid helium. (M.H.R.)

24066 SUPERCONDUCTIVITY. Proceedings of the International Conference on the Science of Superconductivity, Stanford, California, 26–29 August 1969. Chilton, Frank (ed.). Physica; 55: 1-808(Oct 1971). (CONF-690831).

A separate abstract was prepared for each of 98 of the 99 papers included; one paper previously appeared as NSA 24: 28176. (M.H.R.)

For abstracts of individual papers see: 24067–24164.

24067 SUPERCONDUCTING FLUCTUATION EFFECTS ABOVE THE TRANSITION TEMPERATURE. Glover III, R. E. (Univ. of Maryland, College Park). Physica; 55: 3-23(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Experiments that indicate the existence of superconductivity related effects above the transition temperature are reviewed. New results concerning the influence of sample thickness and of both parallel and perpendicular magnetic fields on the fluctuation conductivity are described. (49 references) (auth)

24068 NOISE IN STRONGLY COUPLED JOSEPHSON JUNCTIONS. Stephen, M. J. (Rutgers–The State Univ., New Brunswick, N. J.). Physica; 55: 24-31(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The effects of noise in strongly coupled junctions, in which the density of radiation is high, are considered. Expressions are derived for the dc current–voltage characteristic of the junction, the line width of the emitted radiation, and the normal modes of the junction. These relations are evaluated numerically for various values of the strong-coupling parameter. (auth)

24069 SOME MEASURABLE CONSEQUENCES OF FLUCTUATIONS OF THE ORDER PARAMETER IN SUPERCONDUCTORS. Ambegaokar, V. (Research Inst. for Theoretical Physics, Helsinki). Physica; 55: 32-40(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A general review is given of fluctuations in superconductors and the temperature region in which critical fluctuations occur. It is pointed out that the small parameter governing the critical region does not also generally control the observability of fluctuations in superconductors. This remark is illustrated by elementary and phenomenological discussions of the fluctuation contribution to the electrical conductivity and the magnetic susceptibility. Finally, a brief sketch is given of a microscopic calculation of the contribution of fluctuations to the magnetic susceptibility. (auth)

24070 SYSTEMATICS OF HIGH T_c IN TRANSITION-METAL MATERIALS. Hopfield, J. J. (Princeton Univ., N. J.). Physica; 55: 41-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A theory that expresses the electron–phonon interaction in transition metals in terms of an atomic parameter η and a mean phonon stiffness is reviewed. In this theory, the electronic density of states at the Fermi energy is not a relevant parameter in transition metals as long as it is large. Illustrative examples are given in Nb–Ta and La–Y alloys, for which T_c is correctly interpolated by the present theory, and does not correlate well with γ. The pressure coefficient of T_c in transition metals can be understood if $(d \ln \eta/d \ln V) \approx -3.5$ in all transition metals. In view of these systematics, the most likely materials for higher T_c are compounds whose volume/atom is unusually low. Of such materials, those with abnormally low interatomic force constants (considering the volume/atom) will be good superconductors. The relation between the high-T_c A15-structure transition-metal compounds and the T_c of transition metals is clear in this scheme. The role of violations of the model (which ignores most details due to crystal structure) in searching for higher T_c is briefly discussed. (auth)

24071 HIGHER TEMPERATURES: THEORETICAL MODELS. Little, W. A. (Stanford Univ., Calif.). Physica; 55: 50-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The prospect of obtaining high-temperature superconductivity utilizing an excitonic mechanism rather than the conventional phonon mechanism is reviewed in the light of recent progress in both theory and experiment. The importance of systems of restricted geometry and precisely defined structure is stressed. Experiments currently underway to obtain precise values for the coupling constants of well-defined molecular systems are described, together with progress in the chemical synthesis of several macromolecular systems. (auth)

24072 HIGH T_c: EXPERIMENTAL ACHIEVEMENT. Hulm, J. K.; Walker, M. S.; Pessall, N. (Westinghouse Research Labs., Pittsburgh). Physica; 55: 60-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Data are presented on the superconducting critical temperature, the Debye temperature and the electronic density of states of various NaCl-structure carbides and nitrides of the transition metals. These results are analyzed in terms of the electron–phonon interaction theory of superconductivity. It is concluded that the compounds may be divided into two groups according to the nature of their electronic structure. Some compounds are predominantly sp type, while others are predominantly d type. Data are also presented on the superconducting critical temperature of some solid-solution alloys formed between pairs of compounds. The results suggest that mixing an sp compound with a d compound strongly depresses T_c, whereas T_c maxima frequently occur for alloys between pairs of d-type or pairs of sp-type compounds. (auth)

24073 ANTICORRELATIONS IN SUPERCONDUCTIVITY. Matthias, B. T. (Univ. of California, San Diego, La Jolla. Bell Telephone Labs., Inc., Murray Hill, N. J.). Physica; 55: 69-71 (Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Predictions of and theories for high-temperature superconductors following in the wake of the BCS theory are reviewed briefly and dealt with critically. (M.H.R.)

24074 THERMOMAGNETIC PROPERTIES OF THE MIXED STATE. Fiory, A. T.; Serin, B. (Rutgers–The State Univ., New Brunswick, N. J.). Physica; 55: 73-82(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

After a general introduction, measurements of the Ettingshausen and Peltier coefficients in two niobium and one vanadium specimen are discussed and compared with the revised theory of Maki for clean Type-II superconductors. The ratio, $1/\xi_0$, of electron mean free path to coherence length, exceeds unity in the specimens. Additional data were obtained on the normal-current contribution to the effects. In the purest specimen at 8.8K, it is readily separated from the fluxoid component. It is shown that the normal-current Peltier coefficient below H_{c2} is identical to that above, and that the entropy current density is parallel to the line velocity. Qualitatively, the transport coefficient, α_s, near H_{c2} depends on mean free path as predicted. Quantitative agreement is poor; but it is not clear that the theory applies, and for very large values of $1/\xi_0$, accurate measurement may be impossible. The form of the temperature dependence of the coefficient L(T) is however in good agreement with the data. Data for the entropy transported by an isolated vortex are presented and discussed. Flux-flow resistance curves in the purest specimen have slopes near H_{c2} which depend qualitatively on temperature as predicted. The theory does not account for the field-independent Hall tangent which has been observed, whereas a recent calculation of Bardeen et al. of the structure of an isolated vortex does contain this possibility. The Hall effect in dirty specimens is briefly discussed. (32 references) (auth)

24075 OBSERVATION OF THE MIXED STATE. Essmann, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Physica; 55: 83-93(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Recent experiments on the flux-line arangement in Type-II superconductors are discussed. The experiments indicate that an attractive interaction exists between flux lines in Type-II superconductors with small values of the Ginsburg–Landau parameter. Some results on the mixed state of niobium are presented. (9 figs., 23 references) (auth)

24076 ULTRASONIC ABSORPTION AND THERMAL CONDUCTION IN MIXED STATE OF TYPE-II SUPERCONDUCTORS. Vinen, W. F.; Forgan, E. M.; Gough, C. E.; Hood, M. J. (Univ. of Birmingham, Eng.). Physica; 55: 94-113(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Recent experimental work is reviewed, particular attention being paid first to the situation near H_{c1}, where the electronic excitations can be divided into those that are bound in the flux-line cores, and those that are unbound but are scattered by the flux lines. As expected theoretically, the bound excitations are found to play only a very small role in the two transport properties, except that, somewhat unexpectedly, they are found to absorb thermal phonons strongly. The scattering of the unbound excitations causes a sharp reduction in the transport coefficients, and the nature of the scattering process is discussed in the light of the experimental results. Attention is then paid to the situation near H_{c2}, where the superconducting electrons are almost completely depaired. It is shown that, in dirty superconductors, this situation is fairly well understood, but that there are still important aspects of the experimental results in the clean limit that are not understood. (11 figs., 49 references) (auth)

24077 TRANSPORT IN NONHOMOGENEOUS SUPERCONDUCTORS. Bardeen, J. (Univ. of Illinois, Urbana). Physica; 55: 114-23(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Most theoretical discussions of transport in superconductors in which the gap parameter $\Delta(r,t)$ varies in space and time have made use of local models or of time-dependent versions of the Ginzburg–Landau theory. The general nonlocal theory is difficult to treat mathematically, but progress is being made with use of Green's function methods and with use of the WKB method for solution of Bogolyubov quasi-particle equations. Applications of the latter method to vortex lines in Type-II superconductors and to flow normal to the N–S in the intermediate state of Type-I superconductors are discussed. Although complete solutions were not obtained, it is possible to see qualitatively how the transition from super to normal flow occurs in the boundaries and how electric fields are set up to drive current through the normal regions with consequent dissipation. (auth)

24078 VORTEX MOTION IN SUPERCONDUCTORS. Maki, K. (Tohoku Univ., Sendai). Physica; 55: 124-41(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The recent theory of vortex motion in type-II superconductors as developed by Caroli and Maki and some more recent advances on this subject are reviewed. Limiting to magnetic fields H slightly smaller than H_{c2}, it is shown that the order parameter moves with a uniform velocity u such that $E + u \times B = 0$, where B is the induc-

tion and E is the electric field in the vortex state. The moving order parameter implies the motion of vortex lines with the same velocity. Making use of the moving order parameter thus obtained, various transport currents are calculated. The electric conductivity and the thermomagnetic coefficients are compared with recent experimental data. (auth)

24079 MAGNETIC IMPURITIES IN SUPERCONDUCTORS. Sugawara, T. (Tokyo Univ.). Physica; 55: 143-54(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The recent experimental and theoretical works on the effect of magnetic impurities in superconductors are reviewed, with special emphasis on the effect of anomalous exchange scattering. Experimental evidence is presented which shows that the effect of the anomalous exchange scattering has a considerable contribution to the thermodynamic properties and the electron tunneling. The effect is larger for the impurities which interact with conduction electrons antiferromagnetically than the impurities which interact ferromagnetically. The existence of the bound state, predicted by a number of theories, seems difficult to confirm experimentally, although the anomalies found in electron tunneling into some dilute magnetic alloys seem to bear on it. The effect of the anomalous exchange scattering on the proximity effect is also discussed. (7 figs., 39 references) (auth)

24080 SUPERCONDUCTIVITY IN THIN FILMS AND SMALL PARTICLES. Strongin, M. (Brookhaven National Lab., Upton, N. Y.). Physica; 55: 155-72(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Changes in the superconducting transition temperature of thin films are described. Included is a discussion of T_c changes in soft-metal films and transition-metal films; finally, the lowered T_c in near-monolayer disordered films is also considered. Factors that influence superconductivity in the various cases, such as the phonon spectrum, the density of states, and the metal–insulator boundary are discussed. (12 figs., 44 references) (auth)

24081 SUPERCONDUCTIVITY IN VERY SMALL PARTICLES. Zeller, H. R.; Giaever, I. (General Electric Research and Development Center, Schenectady, N. Y.). Physica; 55: 173-85(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Electron tunneling offers a unique opportunity to study the superconducting state in very small particles. One layer of the particles is imbedded within the oxide layer in an ordinary tunnel junction. The average radius of the small particles is determined directly from electron micrographs. Most of the electrons that flow across the junction will tunnel into and out of one of the imbedded particles. The current–voltage characteristic of such a junction changes markedly when the particles go from the normal to the superconducting state. From this change the energy gap, the transition temperature, and the critical field in small particles with radius of no more than 25 Å are determined. The energy gap and the transition temperature are slightly larger than the bulk values for Sn particles, while the critical field is much larger than would be predicted from simple theories. (24 references) (auth)

24082 SUPERCONDUCTIVITY IN THE ACTINIDE ELEMENTS. Hill, H. H. (Los Alamos Scientific Lab., N. Mex.). Physica; 55: 186-206(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The physical properties of the actinide elements, in the seventh row of the periodic table, are reviewed with emphasis on the occurrence of superconductivity and magnetism in Ac through Cm. The properties of these elements are compared with those of the transition metals and the rare earths, both of which groups are resembled to some extent by the actinides. The superconductors among the actinides are Th, Pa, and U, although the latter (and possibly Pa also) is superconducting in its room-temperature phase only under pressure. The several peculiar superconducting properties of U, especially the positive isotope effect exhibited by α-U under pressure, are discussed. Recent theoretical explanations of the positive isotope effect are considered, and it is suggested that hyperfine interactions may play a role in the superconductivity of this metal. An empirical rule is used to predict the isotope effects in Th and cubic Pa, and the prospects for superconductivity in Ac, Np, Pu, and Am are also discussed. (98 references) (auth)

24083 SUPERFLUIDITY AND SUPERCONDUCTIVITY IN ASTROPHYSICS. Ginzburg, V. L. (Lebedev Physical Inst., Moscow). Physica; 55: 207-12(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The problem of superfluidity and superconductivity in the Universe is briefly summarized (according to the situation at the time of the Stanford conference). (21 references) (auth)

24084 MOMENTUM DEPAIRING IN THE PARACONDUCTING REGIME. Thomas, G. A.; Parks, R. D. (Univ. of Rochester, N. Y.). Physica; 55: 215-23(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Depression of the conductivity by large electric fields at constant temperature in granular aluminum thin films just above the superconducting transition temperature was observed. Spurious effects due to heating were avoided by use of a vacuum-insulated thin-film thermometer in intimate contact with the sample, and the "$E^{-\frac{1}{2}}$ effect" predicted by theory was observed. (auth)

24085 FLUCTUATION EFFECTS IN THE CONDUCTIVITY OF LEAD FILMS. Serin, B.; Smith, R. O.; Mizusaki, T. (Rutgers–The State Univ., New Brunswick, N. J.). Physica; 55: 224-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Resistive transitions near T_c of lead films about 500 Å thick were studied as a function of temperature and of magnetic field applied perpendicular to the plane of the specimen. By extrapolating to large field, the normal-state resistance, R_n, was determined at each temperature, permitting an absolute measurement of the extra conductance due to fluctuations. Both above and below T_c, the results in a field are in excellent agreement with the functional form proposed by Abrahams et al. Below T_c, the factor normalizing the extra conductance is found to be $1.5(e^2/16\hbar)\,(T_c - T)/T_c$. In zero field, above T_c, the reciprocal of the extra conductance is linear in temperature between $R/R_n = 0.48$ and 0.94, with slope $[1.3(e^2/16\hbar)]^{-1}$. Above $1.1T_c$, the extra conductance varies approximately exponentially with temperature, in agreement with recent observations on aluminum. It is suggested that the excessive conductivity far from T_c may be related to that observed close to T_c. (auth)

24086 EFFECT OF A MAGNETIC FIELD ON FLUCTUATIONS ABOVE T_c. Abrahams, R.; Prange, R. E.; Stephen, M. J. (Rutgers–The State Univ., New Brunswick, N. J.). Physica; 55: 230-3(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The extra conductivity due to fluctuations in the presence of a magnetic field H perpendicular to a thin film is calculated as a function of temperature and H. The phenomenological approach is used in which the dynamical behavior of the fluctuations is described, in the spirit of mean field theory, by the time-dependent Ginzburg–Landau equation in the presence of H, and their strength is determined by functional integration over the Ginzburg–Landau free energy. Both the extra longitudinal conductivity σ' and the transverse conductivity were calculated. Here the results are given for σ': $\sigma'(\epsilon,H) = \sigma'(\epsilon,0)f(\epsilon/lH)$, where $\epsilon = (T - T_{c0})/T_{c0}$; T_{c0} is the transition temperature for H = 0 in the bulk, l is the mean free path, $\sigma'(\epsilon,0) = e^2/16\hbar d\epsilon$ and $f(x)$ is a tabulated function. The results are valid outside the critical region above T_c. $\sigma'(H)$ goes as $(T - T_c)^{-1}$ as $T \to T_c$; it approaches $\sigma'(\epsilon,0)$ as $H \to 0$; and for large fields, it goes as const/H. The detailed behavior is in excellent agreement with experimental results of Serin et al. (auth)

24087 SUPERCONDUCTING FLUCTUATION ROUNDING OF THE RESISTIVE TRANSITION OF $Nb_{88}Ti_{12}N$ FILMS. Goldman, A. M.; Schaer, F. M.; Toth, L. E.; Zbasnik, J. (Univ. of Minnesota, Minneapolis). Contract AT-(11-1)-1569. Physica; 55: 234-42(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A detailed study of the resistive transition of $Nb_{.88}Ti_{.12}N$ films was performed from 10 to 50K to test the theory of superconducting fluctuations. A crucial prediction of this theory is a change in the temperature dependence of the resistance corresponding to a change in the ratio of the film thickness to the temperature-dependent coherence length from $d/\xi(T) > 3$ to $d/\xi(T) < 3$. Evidence is presented that this transition was observed. The value of Aslamazov–Larkin parameter obtained from the three-dimensional region ($d/\xi > 3$) is about $\frac{1}{3}$ the value computed from the normal sheet resistance of the film. A remarkable feature of the transition is that the superconducting fluctuations possibly affect the resistivity at temperatures as high as 33K. (auth)

24088 DISORDERED ALUMINUM FILMS. Grassie, A. D. C.; Green, D. B.; Benyon, A. (Univ. of Sussex, Eng.). Physica; 55: 243-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The R–T transitions, critical fields, and currents were studied for films of aluminum deposited in ultrahigh vacua on liquid-helium cooled substrates in such a way as to eliminate edge effects. The critical fields of films thicker than 500 Å show the Ginzburg–Landau temperature dependence with coherence lengths between 200 and 300 Å, and film thicknesses derived from $H_{\parallel}^2/H_{\perp}$ agree with the measured values. The R–T transitions of the thicker films do not fit the Aslamazov and Larkin prediction and changes on annealing the films for short periods indicate that they are inhomogeneous with a range of T_c dependent on crystallite size and intercrystallite coupling. Ultrathin films were found to exhibit superconducting behavior at temperatures close to T_c for thicker films, but their resistances do not decrease to zero at low temperatures and show evidence for thermally activated phase slippage as a contribution to the transition width. (auth)

24089 THICKNESS DEPENDENCE OF THE TRANSITION TEMPERATURE OF SUPERCONDUCTING FILMS. Naugle, D. G.; Glover III, R. E.; Moormann, W. (Univ. of Maryland, College Park). Physica; 55: 250-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A linear dependence of transition temperature on reciprocal film thickness was observed for amorphous films of Bi, Ga, and Al, and for Pb containing 18 at. % Bi. Thinner films had lower transition temperatures than thick ones. This holds for thicknesses above a critical value on the order of a few hundred Å which was different for the different materials. Measurements extended up to several thousand Å. The decrease in transition temperature could equally well be described as being proportional to the residual resistance per square for films of a given composition. The transition temperature of crystalline Pb–Bi films decreased with decreasing thickness, but did not show the linear behavior observed for the amorphous materials. (auth)

24090 THERMAL FLUCTUATIONS AND THE JOSEPHSON SUPERCURRENT. Anderson, J. T.; Goldman, A. M. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1569. Physica; 55: 256-64(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Fluctuations can play an important role in determining the behavior of Josephson junctions when the coupling energy across the junction is the order of thermal energies. This situation can be realized near the critical temperature and near the minima of the $I_1(H)$ curve at low temperatures. In these regimes the effects of thermal fluctuations on the I–V characteristic are quite dramatic. Using a carefully shielded, thermally regulated apparatus the I–V characteristic of an almost ideal Josephson junction in both of these regimes was measured. The results are in qualitative agreement with calculations which treat the problem of thermal fluctuations in a junction using an analogy with the Brownian motion of a particle in a field of force. (auth)

24091 ONSET OF JOSEPHSON TUNNELING AS PROBE OF SUPERCONDUCTING FLUCTUATIONS. Ferrell, R. A. (Univ. of Maryland, College Park. Univ. of Paris, Orsay, France). Physica; 55: 265-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

When one component of a tunneling junction is in the superconducting state but the other is not, fluctuations in the latter cause momentary Josephson currents to flow across the barrier. Application of the Kubo formula yields a paraconductivity inversely proportional to the square of the amount by which the temperature exceeds the transition temperature of the fluctuating film. The frequency dependence of this extra conductivity is a measure of the relaxation rate of the fluctuations. Similarly, the introduction of a spatially dependent phase by means of a current flowing in the superconducting component of the junction permits the sampling of finite wave number fluctuations and the direct determination of the Landau–Ginzburg correlation length. (auth)

24092 ANOMALOUS TEMPERATURE DEPENDENCE IN SUPERCONDUCTING TUNNEL JUNCTIONS. Lipson, S. G.; Kuper, C. G.; Ron, A. (Technion Israel Inst. of Tech., Haifa). Physica; 55: 269-74(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Experiments were carried out on tunneling junctions prepared by Clark's method between pairs of bulk superconductors. The resistance of the junctions was determined at temperatures between the transition temperatures T_1 and T_2 of the two metals. The resistance was found to be a monotonically increasing function of the temperature. Assuming that the barrier can be considered as a very dirty metal, the results are interpreted in terms of a layer of induced gapless superconductivity inside the barrier, thus reducing its effective thickness. The rounding of the discontinuity at T_1 is discussed in terms of Ferrell's paraconductivity. Confirmatory experiments were performed on junctions in which the barrier is replaced by a layer of germanium, with similar results. (auth)

24093 DENSITY OF STATES AND RESISTIVE TRANSITIONS IN THE FLUCTUATION REGIME ABOVE T_c. Abeles, B.; Cohen, R. W.; Fuselier, C. R. (RCA Labs., Princeton, N. J.). Physica; 55: 275-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Data are presented on the rounding of the resistive transition for granular Al and the corresponding electronic density of states (EDS) as determined from tunneling measurements. It is found that the EDS of the granular Al in the fluctuation regime is depressed from the normal-state value over a small energy range $E_c(T)$ centered about the Fermi level. From the values of $E_c(T)$, it is possible to estimate the decay rate $\Gamma(T)/h$ of fluctuations in the Cooper pair density. The values of $\Gamma(T)$ determined from tunneling measurements agree with the theoretical prediction only over a limited temperature range. (auth)

24094 ELECTRIC FIELD DEPENDENCE OF PARACONDUCTIVITY. Klenin, M. A.; Jensen, M. A. (Univ. of Pennsylvania, Philadelphia). Physica; 55: 279-87(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The suppression caused by an applied electric field of the fluctuations (which are responsible for the paraconductivity seen above the superconducting transition) was studied in aluminum films. Of particular interest is a comparison between data taken in the temperature range where the zero-bias conductivity is approximately that predicted by Aslamazov and Larkin and data taken in the temperature range (further from T_c) where significant deviations from their expression are observed. (auth)

24095 INCREASE IN SUPERCONDUCTING TRANSITION TEMPERATURE OF THIN-FILM WEAK LINKS BY MICROWAVES. Wyatt, A. F. G.; Evans, D. H. (Univ., Nottingham, Eng.). Physica; 55: 288-95(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The resistive transition of a weak superconducting link shows that the link has a depressed transition temperature, which is caused by some type of fluctuation. This depression of T_c can be partially removed by directing microwaves onto the sample, and increases of up to 11 millidegrees were measured. The increase in T_c correlates well with the increase in critical current produced by microwaves, which indicates that a law of corresponding states applies. (auth)

24096 INFLUENCE OF MAGNETIC FIELDS ON PARACONDUCTIVITY DUE TO FLUCTUATIONS IN THIN FILMS. Thompson, R. S. (Brookhaven National Lab., Upton, N. Y.). Physica; 55: 296-302(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Recently it was shown that the Aslamazov–Larkin result for the pair conductivity σ' above T_c is incomplete and that an additional contribution of the Maki type must be added, resulting in a logarithmic divergence of σ' for thin films. This divergence can be eliminated by the application of a pair breaking interaction, such as a magnetic field H. For relatively weak H, such that the shift of T_c is of order 10%, the AL result is recovered near the transition for parallel H, whereas eight times AL is obtained for perpendicular H. For relatively strong H, exceeding H_c ($T = 0$) by a few percent, σ' is found to increase initially as T is lowered as if a phase transition would occur at negative T, then to reach a maximum, and finally to vanish as $T \to 0$. (auth)

24097 OBSERVATION OF ENHANCED DIAMAGNETISM ABOVE T_c IN BULK SUPERCONDUCTORS DUE TO THERMODYNAMIC FLUCTUATIONS. Gollub, J. P.; Beasley, M. R.; Newbower, R. S.; Tinkham, M. (Harvard Univ., Cambridge, Mass.). Physica; 55: 303-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Measurements of a temperature-dependent enhanced diamagnetism above T_c in pure bulk tin are presented whose behavior is in general agreement with that expected from the effects of thermal fluctuations. (auth)

24098 MAGNETIC SUSCEPTIBILITY ABOVE THE SUPERCONDUCTING TRANSITION. Vant-Hull, L. L. (Univ. of Houston, Tex.); Mercereau, J. E. Physica; 55: 306-10(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

It was observed that the excess diamagnetic susceptibility of

pure indium and thallium above T_c agrees with the predictions of fluctuation theory. In contrast, the susceptibility of several samples of tin was observed to increase exponentially from $\chi \simeq 10^{-7}$ to $\chi \simeq 2 \times 10^{-4}$ as the temperature approaches T_c, behaving as $\exp(-T/\tau)$ with $\tau \simeq 0.010$ K. In the Meissner transition region exponential behavior again prevails for χ over several decades with $\tau \simeq 0.003$ K, while well below T_c, $\tau \simeq 0.2$ K. For temperatures above T_c in tin, the exponential variation of susceptibility anticipating the superconducting transition was observed to be para- or dia-magnetic, depending upon the sample treatment. (auth)

24099 HIGH-FIELD FLUCTUATION SUPERCONDUCTIVITY IN A BULK EXTREME-TYPE-II SUPERCONDUCTOR. Hake, R. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Physica; 55: 311-16(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Isothermal measurements of the electrical resistivity ρ vs. applied magnetic field H for the bulk extreme-type-II superconducting alloy $Ti_{84}Mo_{16}$ yield evidence for the magnetic field quenching of fluctuation superconductivity. For $t \equiv T/T_c = 0.97$ and $7 < (h \equiv H/H_{c2}) < 14$, the data suggest $\Delta\sigma_f \propto (H - H_{c2})^{-1}$, where $\Delta\sigma_f$ is the extra conductivity due to superconductive fluctuations and H_{c2} is the upper critical field. (auth)

24100 TEMPERATURE DEPENDENCE OF THE CRITICAL CURRENT IN TIN AND INDIUM WHISKERS. Overcash, D. R.; Watlington, C. L.; Skove, M. J.; Stillwell, E. P. (Clemson Univ., S. C.). Physica; 55: 317-23(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The temperature dependence of the critical current in tin and indium whiskers was measured. The results are in quantitative agreement with the Ginzburg–Landau theory and yield a value of ξ_0 equal to 0.22 ± 0.01 μm. Within this uncertainty ξ_0 is isotropic in tin. In whiskers with cross sections less than 1 μm^2, deviations from the Ginzburg–Landau mean field theory are apparent at low currents. These deviations are in accord with the theory of Langer and Ambegaokar. (auth)

24101 FLUCTUATION EFFECTS IN RESISTIVE TRANSITION OF THIN FILAMENTARY SUPERCONDUCTORS. Warburton, R. J.; Patton, B. R.; Webb, W. W.; Wilkins, J. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3029. Physica; 55: 324-38(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A progress report on new and improved measurements of the resistive transitions in tin and tin–indium alloy whisker crystals shows results that can be fitted reasonably well from the onset at low temperature through the excess conductivity tail above the critical temperature by application of existing theories of intrinsic fluctuations. The breadth of the transitions seems to be quantitatively accounted for. The theory of Langer and Ambegaokar as modified by McCumber and Halperin is applicable at the lowest voltage portion of the onset of the transitions at least in pure tin crystals, and the Aslamazov–Larkin theory is applicable at the high temperature tail in alloy crystals. The current dependence of the voltage at T_c and the entire transition shape for alloy whiskers fits a scheme of Masker et al. based on the time-dependent Ginzburg–Landau equations. (10 figs., 13 references) (auth)

24102 SUPERCONDUCTIVITY IN NEARLY ONE-DIMENSIONAL TIN WIRES. Possin, G. E. (Stanford Univ., Calif.). Physica; 55: 339-43(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Tin wires with diameters less than 1000 Å were prepared by electroplating into small holes in mica. The resistance ratios indicate low-temperature electron mean free paths limited only by the geometry. The resistance in the Aslamazov–Larkin region above T_c was measured, and good agreement found with both the predicted temperature dependence and magnitude. (auth)

24103 RELEVANCE OF QUANTUM-PHASE FLUCTUATIONS. Imry, Y. (Cornell Univ., Ithaca, N. Y. Tufts Univ., Medford, Mass.). Contract AT(30-1)-3326. Physica; 55: 344-50(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The long-range fluctuations in the phase of the order parameter are derived for a long thin superconducting specimen using thermodynamic fluctuation theory. Only states with constant phase gradients contribute to the above calculation. The fluctuations are viewed as being of two distinct kinds: (a) fluctuations of the phase difference along a small part of the specimen with a constant overall phase change; (b) fluctuations between (discrete) states with different phase changes over the whole sample. It is argued that the fluctuations of the type (a) are a very short time phenomenon, not related to the destruction of superconductive properties, while the fluctuations (b) relate to and have the same time scale as the decay of metastable currents. The equilibrium superconducting properties are still possible, at given time regimes, in spite of the large phase fluctuations, and without ODLRO. (auth)

24104 TRANSPORT ENTROPY OF VORTICES NEAR H_{c2}. Otter, F. A. Jr.; Solomon, P. R. (United Aircraft Research Labs., East Hartford, Conn.). Physica; 55: 351-6 (Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Data on the transport entropy, S_d, of vortices in three Type-II superconducting alloys ($In_{60}Pb_{40}$, $Nb_{85}Mo_{15}$, and $Nb_{80}Mo_{20}$) are compared with the theoretical predictions of Maki. Maki's theory correctly predicts that S_d approaches zero at $T = 0$ and $T = T_c$ and that S_d goes to zero linearly with B at H_{c2}. The predicted magnitudes are within a factor of 2 of experiment (and sometimes closer). This is reasonable agreement considering the uncertainty in choosing the appropriate value of $\kappa_2(t)$ and the possible errors in the data points. Maki also points out that the difference between the thermal conductivity in the mixed state and in the normal state, $K_m - K_n$ is expressed in terms of the same functions as S_d so that the ratio $(K_m - K_n)/T_c S_d$ should be a universal function of t. This appears to be true for the NbMo alloys, but possibly not for the $In_{60}Pb_{40}$ alloy. (auth)

24105 HALL EFFECT IN THE NORMAL AND FLUX-FLOW STATES OF SOME INDIUM ALLOYS. Byrnak, B.; Rasmussen, F. B. (Univ. of Copenhagen). Physica; 55: 357-61(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Measured flux-flow Hall angles θ_f in four alloys of indium indicate features that are either unaccounted for in present theories or are in contradiction to these theories: (a) there is no simple relation between θ_f and θ_n (the Hall angle in the normal state), not even in sign; (b) the sign may be positive; (c) the numerical value of the maximum θ_f agrees roughly with the product of the cyclotron frequency corresponding to the core field and the depairing time. (auth)

24106 FLUX-FLOW RESISTANCE, ETTINGSHAUSEN EFFECT, AND THERMAL AND MAGNETIC PROPERTIES OF $Nb_{0.8}$–$Mo_{0.2}$ ALLOY. Muto, Y.; Mori, K.; Noto, K. (Tohoku Univ., Sendai). Physica; 55: 362-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The specific heat and the magnetization were measured on $Nb_{0.8}$–$Mo_{0.2}$ alloy in the temperature range from 1 K to 5 K. The analysis of these data gives the Ginzburg–Landau parameter $\kappa = 4.13$ at $T_c = 4.28$ K. The critical fields, $H_{c2}(0)$ and $H_c(0)$, were found to be 5437 Oe and 747 Oe, respectively. This alloy is found to be in the dirty limit of a Type-II superconductor. According to the recent theory of Maki, these fundamental parameters together with the electrical resistivity in the normal state determine the Type-II behaviors of the transport properties of this alloy with respect to their dependences on temperature and magnetic field. In the gapless region, the flow resistance and the entropy of the vortex motion deduced from Ettingshausen coefficients show their magnitudes and the temperature dependences in good agreement with the prediction of this microscopic theory. In addition, the jump in the specific heat at the transition from the mixed state to the normal one was measured at twelve values of the field up to 4566 Oe. This jump may be explained well in terms of the thermodynamical relation at that transition. (auth)

24107 FLUCTUATION SPECTRUM OF FLUX MOTION IN SUPERCONDUCTORS. Burgess, R. E. (Univ. of British Columbia, Vancouver). Physica; 55: 369-75(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The complex resistivity associated with the diffusion and motion of vortex lines in the mixed state is used to derive the equilibrium fluctuation spectrum of the potential difference along a superconducting strip. In the presence of a transport current the drift and creep of the flux contribute nonequilibrium components to the spectrum, and these are derived from the microscopic stochastic details of the transport mechanisms. Some general results for the spectrum are derived for arbitrary geometry. It is shown that the geometries of the strip and the potential probes greatly influence the shape of the spectrum, while its intensity also depends on the statistics of bundle formation. The spectrum for a procession of flux lines depends upon whether they traverse the strip between or outside the probes. (auth)

24108 TIME-DEPENDENT VOLTAGES ACROSS SUPERCONDUCTORS DURING FLUX MOTION. Clem, J. R. (Ames Lab., Iowa). Physica; 55: 376-85(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A simple theory based on the London equations is developed to describe the measured time-dependent voltages across superconductors during flux motion and the associated power spectra. The theory is first used to compute the voltage pulse measured when voltage probe contacts are attached to the surface of a superconducting strip across which a singly-quantized fluxon is moving. The time-dependent voltage and its power spectrum are then calculated for a given distribution of fluxons within the specimen. The theory may be used in general to show that the power spectrum of the measured time-dependent flux-flow voltage depends upon the following factors: the distribution of flux within the specimen, the speed of the flux motion, the width of the specimen, the size of the voltage probe contacts, and the spatial configuration of the leads which attach the contacts on the surface of the superconductor to the voltage-measuring apparatus. (auth)

24109 FLUX MOTION AND NOISE IN TYPE-I SUPERCONDUCTORS. Jarvis, P.; Park, J. G. (Imperial Coll. of Science and Tech., London). Physica; 55: 386-93(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

In the dynamic intermediate state of a type-I superconductor carrying current, the steady voltage V_d is sometimes accompanied by noise with a power spectrum δV_f^2. It is shown that, under these circumstances, V_d and δV_f^2 must correspond to the superposition of voltage pulses; these may be regarded as being due to changes of magnetic flux through the potential leads. In principle, the shape of the pulses is calculable if the position of the flux tubes as a function of time is known. Experiments designed to measure δV_f^2 as a function of applied field suggest that below a field $H/H_c = h_1$, δV_f^2 is approximately proportional to V_d, and varies slightly with the lead configuration, but is reduced by correlation effects when compared with what would be expected for flux tubes moving independently of one another. Above h_1, δV_f^2 has a different spectrum and probably corresponds to processes more complicated than simple flux flow. (auth)

24110 EVIDENCE TO SUPPORT THE RIGIDLY PINNED VORTEX MODEL FOR THE PEAK EFFECT. Lubell, M. S.; Kroeger, D. M. (Oak Ridge National Lab., Tenn.). Physica; 55: 394-8 (Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Data are presented on the peak effect of a Nb–Ti alloy. The temperature dependence of the critical current at a field equal to or higher than the peak field is shown to agree with a model of a rigidly pinned vortex lattice. (auth)

24111 TUNNEL-JUNCTION CURRENT FLUCTUATIONS. Rogovin, D.; Scalapino, D. J. (Univ. of Pennsylvania, Philadelphia). Physica; 55: 399-404(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The dc current flowing across a biased Josephson tunnel junction consists of quasi-particle and pair currents. A simple relationship between the quasi-particle part of the junction I(V) characteristic and the quasi-particle current fluctuation power spectrum $P(\omega)$ is known to exist. Here, a similar relationship between the dc pair transfer part of the I(V) characteristic and the pair transfer part of $P(\omega)$ is constructed. (auth)

24112 NEW THEORY OF THE CURRENT–VOLTAGE CHARACTERISTICS OF WEAK LINKS. Clarke, J. (Univ. of California, Berkeley); Pippard, A. B.; Waldram, J. R. Physica; 55: 405-12 (Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A new theory of the I–V characteristics of superconducting weak links of the SNS sandwich type is outlined. The theory is based on a simple model current-density equation and a careful assessment of the internal impedances of the high- and low-frequency sources present. All the important differences between the characteristics for SNS sandwiches and tunnel junctions are explained at least qualitatively and, to a large extent, quantitatively. A characteristic feature of the theory is the phase-locking of the rate of change of phase across the junction to any applied high-frequency signal. This feature is especially important in understanding the appearance of current steps at the subharmonic voltages ($n\hbar\omega/2em$), and in explaining the extreme steepness of the steps observed. The model is compared with the theories for other types of weak link. (auth)

24113 ANOMALOUS DC CURRENT SINGULARITIES IN JOSEPHSON TUNNEL JUNCTIONS. Chen, J. T.; Finnegan, T. F.; Langenberg, D. N. (Univ. of Pennsylvania, Philadelphia). Physica; 55: 413-20(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Large anomalous dc-current singularities are observed at non-zero voltages in near-ideal Josephson tunnel junctions in the absence of external magnetic field. The voltage positions of these singularities are junction-geometry-dependent, and the amplitudes are temperature-dependent in the direction opposite to the temperature dependence of the zero-voltage dc current. These observations indicate that the junction resonant modes are excited even in homogeneous junctions in zero applied magnetic field. (auth)

24114 FREQUENCY-PULLING EFFECTS IN JOSEPHSON RADIATION. McCumber, D. E. (Bell Telephone Labs., Inc., Whippany, N. J.). Physica; 55: 421-3(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Recent letters by Stephen and by Scully and Lee suggest that the radiation emitted from a small Josephson junction mounted in a finite-Q resonant cavity and biased at a particular dc potential difference V can be shifted from the Josephson frequency $\omega_J = 2\ eV/\hbar$ by cavity detuning. This particular conclusion is not correct, but stems from use of the electrostatic potential V_0 for the electrochemical potential V in the Josephson formula. Cavity detuning can cause V_0 to differ measurably from V, but it does not shift the radiation frequency relative to ω_J. This is consistent with very general thermodynamic arguments dependent upon the relatively weak assumption that the superconductors on each side of the junction are internally in thermal equilibrium. (auth)

24115 DYNAMICS OF SMALL SUPERCONDUCTORS. Notarys, H. A.; Mercereau, J. E. (California Inst. of Tech., Pasadena). Physica; 55: 424-31(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A phenomenological model is discussed for the phase-slip process in small superconducting structures. In this model, Josephson-type phenomena are developed without the concept of transport of flux quanta in the film, but arise from the localized periodic quenching of the superconducting wavefunction by an electric field. (auth)

24116 GENERATION AND DETECTION EXPERIMENTS USING POINT CONTACT-JUNCTION ARRAYS. Clark, T. D. (Philips Research Labs., Eindhoven, Netherlands). Physica; 55: 432-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Various generation and detection experiments are described involving two coupled arrays of 1 mm Sn or Nb spheres. The results appear to show that such arrays can produce substantial amounts of radiation; at least up to the level of maximum detected power ($\sim 2 \times 10^{-6}$ W). (auth)

24117 ELECTRON TUNNELING STUDY OF AMORPHOUS Pb–Bi SUPERCONDUCTING ALLOYS. Chen, T. T.; Leslie, J. D.; Smith, H. J. T. (Univ. of Waterloo, Ont.). Physica; 55: 439-46(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Electron tunneling studies carried out on amorphous Bi and Ga strong-coupling superconductors were extended to a series of amorphous Pb–Bi superconducting alloys, ranging from 100% Pb to 100% Bi. The energy gap and transition temperature were measured for each alloy composition, both in the amorphous state and after annealing to obtain the crystalline state. Phonon spectra were derived for the amorphous state of the alloys by using the McMillan inversion program on the derivative tunneling data. Strong-coupling parameters derived from the phonon spectra were used to test recent theories of the transition temperature of amorphous superconductors. The results are in reasonable agreement with the theories of Benda and of Garland et al. (auth)

24118 PHONON SPECTRA OF AMORPHOUS SUPERCONDUCTORS. Jackson, J. E.; Briscoe, C. V.; Wuehl, H. (Univ. of North Carolina, Chapel Hill). Physica; 55: 447-54(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The techniques of electron tunneling were applied to the study of the amorphous superconductors Ga, Bi(+Pb impurity), and Pb(+Bi impurity). The phonon spectra were computed using McMillan's inversion program. The characteristics of this kind of superconductor are the large Coulomb pseudopotentials and electron–phonon coupling constants. Calculated values of the T_c for a disordered

superconductor using the theory of Garland et al. were in good agreement with the measured values. (19 references) (auth)

24119 SUBHARMONIC STRUCTURE IN SUPERCONDUCTING TUNNEL JUNCTIONS. Giaever, I.; Zeller, H. R. (General Electric Research and Development Center, Schenectady, N. Y.). Physica; 55: 455-61(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A structure is sometimes apparent in the current–voltage characteristic in tunnel junctions at voltages equal to submultiples of the superconducting energy gaps. The origin of this subharmonic structure has never been satisfactorily established. Three new experiments that clearly identify the Josephson effect as the cause of the subharmonic structure are reported here. (auth)

24120 PREFERRED DIRECTION TUNNELING INTO A SUPERCONDUCTOR. Dynes, R. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Carbotte, J. P. Physica; 55: 462-70(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

From detailed phonon information, implied from inelastic neutron scattering experiments, the phonon part of the Eliashberg gap equations, $\alpha^2(\omega)F(\omega)$, appropriate to single-particle tunneling into the high-symmetry directions of a single crystal of a simple metal was calculated. Of more interest than the energy-gap anisotropy, determined from a single iteration of the gap equations, are the differences from the isotropic case predicted in the phonon structure reflected in the tunnel junction conductance. It is found that the critical points are at different energies and are of a two-dimensional nature. (auth)

24121 DEPENDENCE OF QUASI-PARTICLE RECOMBINATION TIME ON FILM THICKNESS. Levine, J. L.; Hsieh, S. Y. (IBM Watson Lab., New York). Physica; 55: 471-4(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

It is found that the measured recombination time of quasi particles in superconducting aluminum films increases approximately linearly with film thickness as predicted by Rothwarf and Taylor, the lifetime for a thickness of 1000 Å being approximately twice the extrapolated value at zero thickness. They suggest that the reabsorbtion of phonons, emitted during the recombination of quasi particles, will lead to an enhancement of the measured quasi particle recombination time proportional to the film thickness, if the main process competing with phonon reabsorbtion is the direct propagation of phonons into the substrate. The results are in semi-quantitative agreement with a simple model based on their discussion. The enhancement is expected to depend on the phonon transmission coefficient. Essentially no effect was observed when layers of WO_3 or CeO_2, having very high acoustic impedances, were interposed between the aluminum film and substrate. There is, at present, no convincing explanation for this result, which casts considerable doubt on the above interpretation of the data. (auth)

24122 ENERGY-GAP ANISOTROPY IN BULK Pb VIA TUNNELING. Blackford, B. L. (Dalhousie Univ., Halifax, N. S.). Physica; 55: 475-83(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A successful tunneling technique was recently reported by the author for investigating energy gap anisotropy in single-crystal Pb. Data from twelve individual junctions are presented here. Two energy gaps Δ_1 and Δ_2 ($\Delta_2 > \Delta_1$) were apparent in all of the characteristics. The observed anisotropy of the tunneling currents associated with the two gaps suggested that Δ_2 is due to electrons from the 2nd zone hole-surface, while Δ_1 is due to electrons from the 3rd zone electron-surface. $\Delta_1(0)$ showed a maximum variation of 5% over the tunneling directions studied. Previously it was reported that $\Delta_2(0)$ remained relatively constant but new data indicate that it varies by about 5% in the vicinity of [001]. The extremal values of $2\Delta_1[0]$ were 2.48 ± 0.01 meV and 2.36 ± 0.01 meV while for $2\Delta_2[0]$ they were 2.74 ± 0.01 meV and 2.88 ± 0.01 meV. The temperature dependence of the dV/dI curves shows that all the gaps have the same transition temperature, which is a characteristic of true anisotropy. The relative amplitudes of the phonon structures in d^2V/dI^2 were found to depend on the tunneling direction. (auth)

24123 SURFACE IMPEDANCE IN PURE TYPE-II SUPERCONDUCTORS. Hibler III, W. D.; Cyrot, M. (Cornell Univ., Ithaca, N. Y.). Physica; 55: 485-91(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A procedure for calculating transport properties in pure Type-II superconductors is presented. In particular, the electrical conductivity for a pure Type-II superconductor in high magnetic fields is calculated for frequencies and relaxation times that satisfy the limit $\omega\tau > 1$. The calculation is carried out in a manner similar to the approach used by Brandt et al. to obtain the density of states. Specifically, the theory utilizes the periodicity of the lattice of fluxoids. In the limit of $qv > \Delta^2/v_F(2eH)^{1/2}$, numerical values for the surface impedance are calculated. The theory predicts a decrease in the surface resistance as the magnetic field is lowered below H_{c_2}, which is highly frequency-dependent, especially for frequencies in the neighborhood of 0.5 GHz. This frequency dependence should be observable experimentally in very pure niobium samples at high frequencies. (auth)

24124 RESISTIVE TRANSITION IN TYPE-II SUPERCONDUCTORS. Gruenberg, L. W. (Massachusetts Inst. of Tech., Cambridge. Sandia Labs., Albuquerque, N. Mex.). Physica; 55: 492-501(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The fluctuation conductivity σ of a Type-II superconductor in a magnetic field greater than $H_{c_2}(T)$ is calculated. A bulk superconductor with $E \perp H$ and $E \parallel H$ and a thin film in a perpendicular field with $E \perp H$ are considered. The conductivity diverges like $(T - T_c)^{-n}$ with $n = 1/2, 3/2$, and 1 in the three cases. In a bulk superconductor, the anisotropy results from an anisotropic lifetime of fluctuations. This also results in an anisotropy in the frequency dependence of σ. Close to T_c, the conductivity is changed drastically by small magnetic fields. The temperature range of this sensitivity is broadest for materials having small κ. The width of the critical region near T_c where the theory breaks down is estimated, and the prediction of a dip in flux-flow resistance at $H_{c_2}(T)$ is discussed. (auth)

24125 SURFACE SUPERCONDUCTIVITY OF Nb AND V. Ostenson, J. E.; Hopkins, J. R.; Finnemore, D. K. (Ames Lab., Iowa). Physica; 55: 502-6(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Surface superconductivity of Nb was studied for several samples with widely varying electronic mean free path. As predicted by Hu and Korenman for the limit of long electronic mean free path, the most pure Nb sample shows H_{c_3} values well above 1.695 H_{c_2} at temperatures below 8.5 K. As the mean free path decreases, there is a regular depression of H_{c_3} toward 1.695 H_{c_2}. At temperatures above 8.5 K, the values of H_{c_3}/H_{c_2} break away from the theory and appear to approach 1.0 rather than 1.695. This aspect of the results occurs for all samples and seems to be relatively insensitive to purity. A vanadium sample with a resistivity ratio of 720 shows characteristics similar to niobium except that deviations from the theory occur at lower reduced temperatures. (auth)

24126 INTERACTION OF PHONONS AND ELECTRONS WITH FLUXOIDS IN MIXED STATE OF TYPE-II SUPERCONDUCTORS. Sousa, J. B. (Clarendon Lab., Oxford). Physica; 55: 507-17(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The field and temperature dependence of the thermal conductivity (K) of some Type-II superconducting alloys, under conditions where the phonon conductivity dominates, was measured to investigate the phonon–fluxoid interaction. The corresponding thermal resistivity (W) is of the form $W = g(T)B$, where $g(T) \propto T^{-b}$, B is the magnetic induction and b is a constant. A simple model based on a normal core fluxoid accounts well for the observed magnitude, field and temperature dependence ($b \approx 1$ for $Nb_{0.98}Ta_{0.02}$ and $b \approx 0$ for $Nb_{0.80}Mo_{0.20}$). Similar measurements were made on pure Nb, where K is essentially electronic. The thermal resistivity due to electron–fluxoid interaction increases linearly with B at low fields. The slope can be related to the fluxoid diameter (a) using a simple model similar to that of Forgan et al. Experiment gives $a = 2.5 \times 10^{-6}$ cm at $T = 0.6\ T_c$, in good agreement with recent experiments. At fields near H_{c_2} fluxoids overlap and the scattering dies away. (auth)

24127 ATOMIC BEAM STUDY OF Nb IN THE VORTEX STATE. Brown, T. R.; King, J. G. (Massachusetts Inst. of Tech., Cambridge). Physica; 55: 518-21(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Transitions were observed in a state-selected beam of neutral potassium atoms by passing them over the surface of an Nb cylinder. These transitions arise because of the motion of the atoms through the spatially periodic magnetic field of the vortex lattice which extends for several 100 Å outside the surface. The use of this technique in studying vortex motion as well as microscopic field variations in other systems will be discussed. (auth)

24128 LOW-TEMPERATURE ANNEALING EFFECTS ON THE SUPERCONDUCTING PROPERTIES OF V_3Au. Hein, R. A. (Naval Research Lab., Washington, D. C.); Cox, J. E.; Blaugher, R. D.; Waterstrat, R. M.; van Reuth, E. C. Physica; 55: 523-33(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The superconducting transition temperature, T_c, and the initial slope of the upper critical magnetic field curve of V_3Au were measured as functions of low (400°C to 800°C) temperature annealing. T_c ranges from no superconductivity down to 0.015 K to a T_c as high as 3.22 K. X-ray diffractometer data indicated that all the samples employed in this study had the A15 structure. Metallographic studies indicated the presence of a few percent of a second Au rich phase in these equilibrated samples. The x-ray data also indicated that the low-temperature anneals did change the degree of crystallographic long range order present in the samples and our data clearly indicate that T_c increases quite markedly as the Bragg–Williams long-range order parameter approaches the value of unity. The magnitude of the initial slope of the critical magnetic field curve also increases with increase in T_0 (from -22×10^3 Oe/deg to -37×10^3 Oe/deg for T_0 = 0.89 K and 3.1 K respectively) with one notable exception, and that is the sample with the highest T_c for which the slope has its smallest value, namely -16×10^3 Oe/deg. (auth)

24129 PROPERTIES OF Nb_3Al IN HIGH MAGNETIC FIELDS. Foner, S. (Massachusetts Inst. of Tech., Cambridge); McNiff, E. J. Jr.; Geballe, T. H.; Willens, R. H.; Buehler, E. Physica; 55: 534-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The critical field versus temperature for almost single-phase Nb_3Al was measured and compared with the properties of other β-tungsten superconductors. Magnetic moment measurements above the critical field show that the normal-state susceptibility is nearly independent of temperature for T below T_c. These results and earlier measurements above T_c indicate that the Labbé–Friedel model is not appropriate for the description of Nb_3Al. The results are compared to earlier results in high-temperature NbGeAl alloys. (auth)

24130 EFFECT OF UNIAXIAL STRESS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF MONOCRYSTALLINE Nb_3Sn. McEvoy, J. P. (RCA Labs., Princeton, N. J.). Physica; 55: 540-4(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Measurements were made of the stress dependence of the superconducting transition temperature (T_c) of single crystals of Nb_3Sn oriented in the (001) direction. The magnitude of the stress dependence of T_c is about 1,000 times larger than that generally observed for elemental superconductors. The results further imply that below the tetragonal transformation temperature (T_m), the crystal consists of tetragonal domains with variable orientation of the c axis and that the domain configuration and T_c depend on the applied stress at T_m. (auth)

24131 LINEAR CHAIN MODEL FOR THE β-W LATTICE. Weger, M. (Service de Physique des Solides, Orsay, France). Physica; 55: 545-53(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The validity of the linear chain model for the β-W crystal structure is investigated when coupling between the chains is taken into account. It is shown that a one-dimensional character persists in the presence of moderate interchain and interband interaction giving rise to constant energy surfaces in the form of torn-out planes. (auth)

24132 EFFECT OF GRAIN SIZE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF TRANSITION METALS. Hanak, J. J.; Gittleman, J. I. (RCA Labs., Princeton, N. J.). Physica; 55: 555-61(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A systematic study of the effect of reducing grain size on La and Mo was made. The results indicate that existing strong-coupling theory is not applicable to the transition metal unless the particle-size dependence of the coupling constant can be related to changes in the density of states as well as to lattice softening. T_c measurements were made for granular superconductors formed by cosputtering La and Mo with quartz and with appropriate elements. In all cases, T_c of bcc Mo was enhanced to values between 5.7 and 8 K and the T_c of α-La was decreased with diminished grain size. (auth)

24133 NORMAL AND SUPERCONDUCTING PROPERTIES OF NIOBIUM-RICH NIOBIUM–TANTALUM ALLOYS. Ohtsuka, T. (Tohoku Univ., Sendai); Kimura, Y. Physica; 55: 562-70(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Mainly specific heat measurements were made on Nb and Nb-rich Nb–Ta alloys to clarify experimentally how strong-coupling and anisotropic features of superconducting pure Nb vary with the introduction of impurity. It is found that the behavior of the thermodynamic critical field H_c and values of the reduced quantities $2\Delta(0)/k_BT_c$, $\Delta C/\gamma T_c$ and $H_c(0)^2/\gamma T_c^2$ tend monotonically towards the BCS predictions with Ta content. Both the upper critical field at 0 K, $H_{c2}(0)$ and the initial slope $(-dH_{c2}/dT)_{T=T_c}$ increase with Ta content. However, the reduced quantity $h^*(0) = H_{c2}(0)/(-dH_{c2}/dT)_{T=T_c}$ decreases with Ta content from an anomalously large value $h^*(0) = 0.835$ but is still larger than the theoretical pure limit value at 30 at.% Ta. The results are presented in the presence of both retardation and anisotropy. (auth)

24134 SOFT-MODE SUPERCONDUCTIVITY IN $SrTiO_{3-x}$ AND $Ca_ySr_{1-y}TiO_{3-x}$. Appel, J. (Gulf General Atomic Inc., San Diego, Calif.). Physica; 55: 577-84(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

In these nearly ferroelectric titanates, the effective electron–electron interaction has an attractive part caused by the virtual exchange of soft optical phonons which have been observed in the tetragonal phase with Raman scattering and neutron diffraction. These phonons have even symmetry (A_{1g} at q = 0) and their electron–phonon matrix element is finite, independent of the symmetry character of the electron states. The matrix element is proportional to the order parameter for the cubic → tetragonal phase-transition, namely, the angle of rotation φ of the oxygen octahedra around the tetragonal axis (φ is different for the two titanates). The Coulomb part of the effective interaction is determined by the longitudinal dielectric constant for a degenerate polar semiconductor. In the important low-frequency range where the soft phonons provide an attractive interaction, the Coulomb repulsion is weak because the lattice polarization can follow the motion of a conduction electron. With this effective interaction, the superconducting transition temperature T_c of $SrTiO_{3-x}$ and $Ca_ySr_{1-y}TiO_{3-x}$ is calculated as a function of the electron concentration. The deformation potential for the interaction between electrons and soft optical phonons is used as an adjustable parameter to fit T_c at one experimental point. The results are in good agreement with the experimental data. (23 references) (auth)

24135 SUPERCONDUCTING PROPERTIES AS A FUNCTION OF THICKNESS IN NbN FILMS. Gavaler, J. R.; Janocko, M. A.; Hukm, J. K.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). Physica; 55: 585-91(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Niobium nitride, NbN, films with thicknesses ranging from 5000 Å down to approximately 10 Å were prepared by a high-purity reactive sputtering process and their superconducting properties measured. A depression in transition temperature, T_c, with decreasing thickness was observed, starting from a maximum T_c of ≈15.2 K in the thicker films down to ≈6.5 K in a 25 Å film. The critical current vs. applied magnetic field curves were found to be independent of thickness or even to increase slightly down to a thickness of 100 Å. Below this point the critical current at high fields decreased sharply, the films apparently becoming discontinuous. The average resistivity of the NbN films was ≈1000μ ohm cm. (auth)

24136 SPECIFIC-HEAT MEASUREMENTS ON SUPERCONDUCTING Ce–La ALLOYS. Edelstein, A. (Univ. of Illinois, Urbana. Argonne National Lab., Ill.); Culbert, H. Physica; 55: 592-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

In Ce_xLa_{1-x} alloys one can study the co-existence of the Kondo effect and superconductivity. The first electron tunneling measurements by Edelstein on such a system were made on this alloy system. These measurements on alloy films showed that these alloys were gapless at the concentrations investigated. The number of states at the Fermi surface in the concentration range $0.002 \leq x \leq 0.005$ was proportional to the impurity concentration. If the first Born approximation were applicable, there would not have been any states. Hence, unlike the Kondo effect these measurements provided direct microscopic evidence for the failure of the first Born approximation. Specific heat measurements on bulk samples indicate that the tunneling results were indicative

of bulk samples. The low temperature ($0.5\ K \leq T \leq 3.0\ K$) specific heat contains a γT term. Such a term implies the existence of states at and around the Fermi surface. For $x = 0.001$, 0.002, 0.005, and 0.0075, values of $\gamma = 0.11 \pm 0.08$, 0.90 ± 0.05, 2.40 ± 0.20, and 4.66 ± 0.04 mJ/mole K^2 were obtained. These specific heat results are in agreement with the tunneling results. The fact that there is a critical Ce concentration below which there are no states at the Fermi level has important theoretical implications. (auth)

24137 PROBLEM OF COEXISTENCE OF SUPERCONDUCTIVITY AND FERROMAGNETISM. Fischer, Oe.; Peter, M. (Univ., Geneva). Physica; 55: 597-607(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The suggestion of Jaccarino and Peter to compensate the exchange field in a ferromagnet by an external field to make possible the coexistence of ferromagnetism and superconductivity is analyzed. The coexistence is, however, only possible if the critical field (without Pauli paramagnetism effects) is at least of the order of the mean exchange field. To reach high orbital critical fields one has to introduce disorders and impurities in the system. However, in a ferromagnetic system, this leads to strong exchange scatterings tending to reduce H_{c2}. Only in superconductors with an extremely high κ_0 does it seem possible to reach the critical fields necessary to realize the compensation. (auth)

24138 PREPARATION AND THE SUPERCONDUCTING PROPERTIES OF $CeRu_2$ AND ITS MIXED CRYSTALS WITH ARu_2 (A = RARE-EARTH ELEMENT) AND CeB_2 (B = Mn, Fe-GROUP OR Pt-GROUP ELEMENT). Wilhelm, M.; Hillenbrand, B. (Siemens AG, Erlangen, Ger.). Physica; 55: 608-14(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The preparation and the superconducting properties of $CeRu_2$ and its mixed crystals $Ce_{1-x}A_xRu_2$ and $Ce(Ru_{1-x}B_x)_2$ (A = rare-earth element, B = Mn, Fe-group or Pt-group element) are reported. Homogeneous samples of the compound and its solid solutions were prepared by a special heat treatment, and the initial susceptibility was measured as a function of temperature. For small concentrations of rare-earth elements T_c is slightly increased as compared with pure $CeRu_2$ ($T_c = 6.2$ K), for larger concentrations T_c decreases approximately with the fourth power of the concentration. Superconductivity and magnetism meet for alloys with ≈13 mole % $GdRu_2$, 18 mole % $TbRu_2$, 21 mole % $DyRu_2$, and 27 mole % $HoRu_2$. For $Ce(Ru_{1-x}B_x)_2$ T_c decreases linearly with x, dT_c/dx being especially large for Mn and Fe. Since the available cerium showed a Fe-content of several thousand ppm, the metal was zone-refined before use. From the different behavior of the A- and B-solutions, it is concluded that superconductivity may be connected with the Ru sublattice. (auth)

24139 5f ELECTRONS AND SUPERCONDUCTIVITY: DILUTE ALLOYS FORMED BETWEEN LANTHANUM AND ACTINIDE METALS. Hill, H. H.; Lindsay, J. D. G.; White, R. W.; (and others) (Los Alamos Scientific Lab., N. Mex.). Physica; 55: 615-21(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Small amounts of the metals Th, U, Np, PuI, and Am were dissolved individually into fcc La, and the superconducting transition temperatures T_c of the alloys were measured and compared with that of La. Th decreased T_c of La only very weakly, and U seemed to do likewise. Np and Pu depressed T_c quite strongly, as does the anomalous rare-earth metal Ce. Am does not appear to possess a magnetic moment in La. The present data complement previous work on the 4f metals and illustrate some differences between the first few transactinium metals and their counterparts in the rare-earth series. (auth)

24140 POSSIBLE SPIN-FLUCTUATION EFFECTS ON SUPERCONDUCTIVITY IN THE 4d HCP TRANSITION SERIES. Riblet, G.; Jensen, M. A. (Univ. of Pennsylvania, Philadelphia). Physica; 55: 622-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The superconductivity of hcp Mo–Ir, Mo–Rh, Ru–Ir, Ru–Pt, Ru–Rh, Ru–Co, and Ru–Ni alloys down to .030 K was investigated. When data on T_c, χ, and γ are compared for different systems, a correlation emerges between the rates of decrease of T_c and increase of χ and γ as the electron-to-atom ratio increases. This correlation is most readily explained by the theory of spin fluctuations. (auth)

24141 MAGNETIC INTERACTIONS IN SUPERCONDUCTING LANTHANUM INTERMETALLIC COMPOUNDS. Toxen, A. M.; Gambino, R. J.; van der Hoeven, B. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). Physica; 55: 626-30(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Measurements of the electronic specific heat and susceptibility of the superconducting intermetallic compound $LaIn_3$ indicate that the susceptibility is exchange enhanced by a factor of 5.76. This corresponds to an effective electron–electron interaction of 2.91 eV. Using a simple model for the electronic density of states which postulates a peak in the vicinity of the Fermi energy, a good fit to the experimental temperature-dependent susceptibility is obtained. (auth)

24142 ULTRASONIC ATTENUATION IN SUPERCONDUCTING MOLYBDENUM–RHENIUM ALLOYS. Ashkin, M.; Deis, D. W.; Gottlieb, M.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). Physica; 55: 631-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The attenuation of longitudinal sound in superconducting molybdenum–rhenium was investigated as a function of temperature T, magnetic field H, and frequency ν. Measurements up to 3 GHz were possible in a [100] sample of Mo–25 Re ($T_c = 10.25$ K) using evaporated thin-film CdS transducers. The normal-state attenuation coefficient (0.43 dB/cm at 1 GHz) was found to be proportional to ν^2 over this range, consistent with the condition $ql \ll 1$, as would be expected from the measured residual resistivity ratio of 2.8. Measurements in zero magnetic field yielded a value of the energy gap parameter close to the theoretical value of $3.56\ kT_c$ appropriate to a weakly coupled ($T_c/\theta_D \ll 1$) dirty limit ($l < \xi_0$) superconductor. It is found that α varies linearly with H over most of the region of the mixed state $H_{c1} < H < H_{c2}$, in general qualitative agreement with the theory of Houghton and McLean for the extreme dirty limit of a Type-II superconductor. (auth)

24143 SUPERCONDUCTING PROPERTIES OF STRONG-COUPLING Pb–In ALLOYS. Rothwarf, F. (Pitman-Dunn Labs., Philadelphia); Dubeck, L. W.; Aston, D. R. Physica; 55: 636-42(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Magnetization measurements were made for a series of Pb–In alloys containing up to 28 at. % indium as a function of temperature and applied magnetic field. They were used to calculate in three ways the ratio of the energy gap at absolute zero, $\Delta(0)$, to T_c, where T_c is the transition temperature, for each sample. First a BCS formula, strictly valid only for weak-coupling superconductors, was employed. Secondly, a formula proposed by Sheahen was used. Finally, an equation due to Toxen was used. These three determinations agreed with each other within the experimental error and with values of the energy gap measured by tunneling methods. These results and the calculation of the superconducting specific heat at T_c from the magnetization measurements indicate that the Pb–In system behaves as a strong-coupling superconductor for alloys containing up to 28 at. % indium. (auth)

24144 ANOMALOUS MICROWAVE ABSORPTION IN SUPERCONDUCTORS. van Gelder, A. P. (Katholieke Univ., Nijmegen, Netherlands). Physica; 55: 643-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A calculation of the surface impedance of superconductors was given by Mattis et al., where electron scattering at the surface was considered to be random or specular. The present treatment is equivalent with the previous ones as far as the linear transport theory is concerned, but makes use of a different type of boundary condition by requiring that the electron wave functions vanish at the surface. This is the quantum-mechanical consequence of an-assumed-rigid potential barrier. It is found that the correction to the surface impedance, relative to the theory based on the speculum assumption, depends sensitively on the Landau–Ginzburg parameter κ. It is largest (≈40%) for frequencies well below the gap ($\hbar\omega \approx 10^{-2}\Delta$), and it decreases rapidly if the frequency is increased towards the gap. It seems legitimate to conclude that this correction may account for the discrepancy between Miller's calculation and experiments. (auth)

24145 PENETRATION DEPTH IN SUPERCONDUCTING ALUMINUM AS A FUNCTION OF MAGNETIC FIELD AND TEMPERATURE. Behroozi, F.; Garfunkel, M. P. (Univ. of Pittsburgh). Physica; 55: 649-55(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The penetration depth in pure single crystals of aluminum

was determined as a function of magnetic field and temperature at a frequency of about 0.5 MHz. The temperature dependence is found to be qualitatively in agreement with the predictions of the BCS theory. A static magnetic field (less than the critical field) is found to increase the penetration depth at all temperatures, having a maximum effect at a reduced temperature, $t = T/T_c \approx 0.55$. The details are in essential agreement with the predictions of Garfunkel, whose model attributes the effect of a magnetic field in a Type-I superconductor to the change in kinetic energy of the electrons in the Meissner current. (auth)

24146 HYPERSOUND ATTENUATION IN SUPERCONDUCTING MOLYBDENUM. Garfunkel, M. P.; Pike, G. E. (Univ. of Pittsburgh). Physica; 55: 656-61(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The attenuation of 9.4-GHz longitudinal hypersound along the [111] direction in superconducting molybdenum was measured as a function of temperature. The results show a rapid (almost discontinuous) change in attenuation occurring at T_ν, a temperature ≈0.009 K below the superconducting transition temperature, T_c (= 0.914 K). A detailed analysis shows that the results can be fit within experimental error by a simple two gap model of superconducting molybdenum with gaps $2\Delta_1(0) = 2.5\ kT_c$ and $2\Delta_2(0) = 3.1\ kT_c$. These results confirm the form of the predictions of the BCS theory for acoustic attenuation in the frequency regime where phonons excite quasi particles across the energy gap. The normal-state attenuation just above T_c is found to be 52.9 dB/cm GHz. (auth)

24147 CRITICAL MAGNETIC FIELDS OF ALUMINUM, GALLIUM, AND THORIUM UNDER PRESSURE AND THE ISOTOPE EFFECT OF CADMIUM. Palmy, C.; Flach, R.; de Trey, P. (Swiss Federal Inst. of Tech., Zurich). Physica; 55: 663-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Critical field curves of the superconductors Al, Ga and Th under pressures up to 25 kbar and down to temperatures of 0.3 K are given. Improved measurements on the isotope effect in cadmium are also reported. The electronic Grueneisen constant is deduced for the investigated metals. (auth)

24148 GENERALIZED McMILLAN EQUATION. Garland, J. W. (Univ. of Illinois, Chicago. Argonne National Lab., Ill.); Allen, P. B. Physica; 55: 669-77(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The superconducting transition temperature T_c, energy gap Δ_0, and tunneling density of states $N_T(\omega)$ were calculated for several elements, with results in good agreement with experiment. Combining the results with the work of McMillan and Leslie et al., a generalized form of the McMillan equation was found that contains only one additional parameter $\langle(\omega/\omega_0)^2\rangle$, and which differs significantly from the original McMillan equation for most strong-coupling superconductors. The parameter $\langle(\omega/\omega_0)^2\rangle$ is a measure of the spread in the phonon spectrum and can be determined either from $N_T(\omega)$ or from a calculated $\alpha^2(\omega)F(\omega)$ using neutron-diffraction measurements of the phonon spectrum. As is shown elsewhere, this equation is valuable in calculating the effects of lattice disorder on superconductivity. (auth)

24149 CALCULATION OF THE PENETRATION DEPTH AND ELECTROMAGNETIC ABSORPTION EDGE FOR STRONG-COUPLING SUPERCONDUCTORS. Swihart, J. C.; Shaw, W. (Indiana Univ., Bloomington). Physica; 55: 678-90(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The electromagnetic response function was calculated for various cases for a model of lead, both for the pure metal and a dilute nonmagnetic alloy, and both for the weak-coupling and strong-coupling theories using Nam's theory. With these results, the low-frequency penetration depth and the high-frequency surface resistance were calculated in the neighborhood of the gap edge for these various cases. A penetration depth was found for strong-coupling pure lead of 406 Å in better agreement with the experimental result of 390 Å than previous calculations. The calculated absorption edge is steeper for the strong-coupling theory than for the weak-coupling theory and also is in good agreement with the experimental results of Leslie and Ginsberg and of Norman. The alloy calculation has a slightly steeper absorption edge than the calculation for the pure metal. (auth)

24150 S-STATE INSTABILITIES FOR RETARDED INTERACTIONS. Owen, C. S.; Scalapino, D. J. (Univ. of Pennsylvania, Philadelphia). Physica; 55: 691-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The effective electron–electron interaction in superconductors is characterized by its short range and retardation. The occurrence of two-particle s-wave instabilities was studied for various retarded potentials. Formally the results are related to the question of whether other particle–particle s-wave instabilities would occur if a superconductor could be super-cooled below its ordinary transition temperature which is associated with the first s-wave instability. Under the conditions outlined below, only a single s-wave instability associated with the standard superconducting transition temperature is found. The analysis is then turned to the problem of evaluating T_c for strong-coupling superconductors. (auth)

24151 ELECTRON–PHONON INTERACTIONS IN TRANSITION METALS. Harrison, A. (Stanford Univ., Calif.). Physica; 55: 696-701(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The construction of an electron–phonon interaction requires the separation of the Hamiltonian describing mutually interacting electrons and ions into terms representing electronic quasi particles, phonons, and a residual interaction. Such a separation of the electron–ion self-consistent-field Schroedinger equation for transition metals was made, without approximation, leading to an interaction that is manifestly small. The corresponding form factors for copper are displayed. The interaction between phonons and s-like states contains hybridization terms, in addition to a term analogous to the simple metal pseudopotential. These may be viewed as second-order terms in which an electron (or a hole) scatters through an intermediate d-like state. These terms are comparable to the usual pseudopotential and are treated as of the same order. They also give rise to screening fields just as do the simpler pseudopotential terms. (auth)

24152 METALLIC HYDROGEN. II. HIGH-TEMPERATURE SUPERCONDUCTIVITY. Schneider, T.; Stoll, E. (IBM Research Lab., Zurich). Physica; 55: 702-10(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The possibility and the consequences of high-temperature superconductivity in the proposed metallic phase of hydrogen are discussed. Using the results of an earlier paper, the pressure dependence and the connection of high-temperature superconductivity with metallic hydrogen properties are considered also. (auth)

24153 MIXED-STATE PROPERTIES OF In–Zn SUPERIMPOSED LAYERS. Martinoli, P. (Swiss Federal Inst. of Tech., Zurich). Physica; 55: 711-17(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The perpendicular critical fields and the critical depinning currents in the mixed state of superconducting thin films were measured. The effect on the same quantities due to the proximity of a normal metal was also investigated. The measurements were carried out on In films and on films of In with a Zn layer superimposed. The results are discussed in the light of the Ginzburg–Landau theory and compared with calculations appropriate to the present case. (auth)

24154 TUNNELING INVESTIGATION OF PROXIMITY EFFECT IN THICK LEAD FILMS BACKED BY IRON. Rowell, J. M.; McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Physica; 55: 718-26(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

A recent theory of the superconductor/normal-metal interface makes definite predictions of the amplitude (and its energy dependence) of the Tomasch oscillations observed in tunneling into a superconductor backed by a normal metal. Measurements of this amplitude in Al/I/Pb/Fe junctions are presented and in particular, the mean free path dependence of the amplitude is illustrated. In Pb films less than 1μ thick gaplessness produced by the Fe is observed. The effect of Fe on the phonon-induced structure in thin Pb films is also reported. (auth)

24155 ENERGY SPECTRUM AT THE INTERFACE OF A SUPERCONDUCTING–MAGNETIC FILM: INFLUENCE ON MICROWAVE ABSORPTION. Brochard, F.; Deutscher, G.; Holzer, W.; Pincus, P.; Waysand, G. (Laboratoire de Physique des Solides, Orsay, France). Physica; 55: 727-32(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The changes in the BCS spectrum of electronic excitations induced by the proximity of a magnetic metal with a superconducting film are investigated theoretically. It is assumed that the reflection of electrons is specular at the interface and that the order parameter vanishes in the magnetic metal and increases

linearly over a distance equal to the coherence length. Experimental results are presented for an In–Bi superconductor with a manganese antiferromagnetic layer to produce the proximity effect. (M.H.R.)

24156 COUPLING BETWEEN FERRIMAGNETIC INSULATORS THROUGH A SUPERCONDUCTING LAYER. Hauser, J. J. (Bell Telephone Labs., Murray Hill, N. J.). Physica; 55: 733-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

In agreement with a recent theoretical prediction of de Gennes, the transition temperature of In (or another superconductor) films sandwiched between two magnetic films depends on the relative orientation of the magnetization of these ferrites. The highest transition temperature (nearly the T_c of bulk In, 3.4 K) is obtained when the two ferrites are deposited in antiparallel magnetic fields, while the lowest (≈1 K) occurs when the ferrites are deposited in parallel magnetic fields. The depression of the transition temperature of indium films sputtered or evaporated between two magnetic films magnetized in parallel fields is inversely proportional to the thickness of the In films. (auth)

24157 EXPERIMENTAL EVIDENCE FOR SUPERCONDUCTIVITY ENHANCEMENT MECHANISM. Klein, J.; Leger, A. (SNRS, Paris). Physica; 55: 740-3(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

It is known that metallic films composed of small grains have an enhanced transition temperature. Many theoretical explanations have been proposed, but none have yet received direct experimental confirmation. In this work, it is shown, by tunneling experiments, that the enhancement of T_c in granular Al films is related to the appearance of low-frequency modes in the phonon density of states $F(\omega)$. Using the results of McMillan's theory, T_c is calculated and comparison with the experimental value is quite good. (auth)

24158 TUNNELING STUDIES OF PROXIMITY AND BOUNDARY EFFECTS. Prothero, D. H.; Freake, S. M.; Adkins, C. J. (Royal Society Mond Lab., Cambridge, Eng.). Physica; 55: 744-8(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

High-resolution measurements showing how the density of states induced in copper by the proximity of superconducting lead varies as the metals are decoupled by the addition of scattering material at the Cu/Pb interface are presented. If the energy gap in the copper is not too small (say $\gtrsim$0.3 meV) the density of states in the decoupled case is similar to that which is found with a clean interface if the copper thickness is increased to give the same value of the energy gap in the copper. The similarity includes the unexplained dip in the density of states at the energy gap of the lead which is present for energy gaps in the copper between about 0.2 and 0.6 meV. For films which are strongly decoupled the density of states in the copper becomes more like that predicted by the McMillan model in that the density of states remains enhanced up to the lead gap. (auth)

24159 SUPERCOOLING AND SUPERHEATING IN Al AND Zn. de la Cruz, F.; Maloney, M. D.; Cardona, M. (Brown Univ., Providence). Physica; 55: 749-59(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The supercooling and superheating of Al and Zn were studied in the temperature range between 0.5 and 1.2 K. The samples, collections of dispersed and isolated small spheres, were prepared by spraying of the molten metal into liquid nitrogen. The supercooling and superheating fields obtained are, by all indications, close to the theoretical limit. From the supercooling fields observed, the Ginzburg–Landau parameter $\kappa(T_c) = 0.015$ was determined for both Al and Zn. The superheating field exhibits a strong temperature dependence near T_c, which reflects the extremely nonlocal electrodynamics of the materials. The results are discussed in the light of recent theoretical work. (auth)

24160 TEMPERATURE DEPENDENCE OF THE BERNOULLI EFFECT IN A TYPE-I SUPERCONDUCTOR. Morris, T. D.; Brown, J. B. (Univ. of Kent, Canterbury, Eng.). Physica; 55: 760-4(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Measurements of the Bernoulli potentials observed in superconducting lead were extended to the transition temperature. The temperature dependence of the effect is found to be consistent with the two-fluid equations including a fountain-effect term as proposed by Van Vijfeijken and Staas. The potentials observed are shown to be related to the stress-induced potentials encountered in the experiments of Witteborn and Fairbank. (auth)

24161 INFLUENCE OF OSCILLATORY MAGNETIC FIELDS ON THE ELECTRICAL RESISTANCE IN THE INTERMEDIATE STATE OF SUPERCONDUCTING LEAD FILMS. Huebener, R. P.; Rowe, V. A. (Argonne National Lab., Ill.). Physica; 55: 765-71 (Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The electrical resistance of superconducting lead films with thickness around 3 μm was measured in a perpendicular magnetic field H_0 at 4.2 K. A small oscillatory field H_1 with frequency ω was applied parallel to H_0, with $|H_1/H_0| \approx 10^{-3}$. The resistive voltage was found to pass through a maximum as a function of ω. The frequency ω^* associated with the maximum voltage was rather independent of the sample current and the amplitude of H_1. However, ω^* increased strongly with increasing field H_0. A reduction in the specimen area also shifted ω^* to higher values. It is suggested that the voltage peaks are associated with compressional eigen modes in the flux structure of the films. The elastic properties of the system are very likely dominated by the long-range interaction between the flux bundles near the two surfaces of the films. (auth)

24162 ELECTRON–DISLOCATION INTERACTION IN SUPERCONDUCTORS. Tittmann, B. R.; Alers, G. A.; Buck, O. (North American Rockwell Corp., Thousand Oaks, Calif.). Physica; 55: 772-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

During plastic deformation, the transition from the normal to the superconducting state and vice versa changes the flow stress in both Type-I and Type-II superconductors by several percent. A detailed examination of this change in flow stress was made by measuring its dependence on work hardening, strain rate, and temperature in specimens of lead and indium. An $[1 - (T/T_c)^2]$ temperature dependence but no strain-rate dependence was found. Furthermore, the shape of the stress–strain curve at the transition indicates that plastic flow actually stops when the material enters the normal state. These experimental results suggest that the dislocations are bound more securely to their pinning points in the normal state than in the superconducting state. (auth)

24163 NONLOCAL SUPERCONDUCTIVITY AND THE CRITICAL FIELD H_{c2} OF NIOBIUM. Williamson, S. J. (North American Rockwell Corp., Thousand Oaks, Calif.). Physica; 55: 780-5(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

The critical field H_{c2} of pure, single crystal niobium was experimentally found to have a temperature dependence of the form $H_{c2}(t) = H_{c2}(0)[1 + \eta t^2 \ln(t)]$ in the temperature range $0.4\ K \leq T \leq 1.4\ K$, where $t = T/T_c$. Although the constant η is found to be anisotropic, as is H_{c2}, this temperature dependence agrees with a prediction by Gor'kov for clean, Type-II superconductors with isotropic Fermi surfaces in the low-temperature limit. (auth)

24164 COLLECTIVE EXCITATIONS IN NARROW SUPERCONDUCTING STRIPS. Shepard, K. W. (Stanford Univ., Calif.). Physica; 55: 786-9(Oct 1971).

From Conference on science of superconductivity; Stanford, Calif. (26 Aug 1969).

Thin aluminum films scribed into strips several microns wide and a few mm long were irradiated with microwaves of wavelength comparable to the length of the strips. The microwave source is an electron cyclotron maser, of the sort devised by Bott, tunable in wavelength from 12 to 2 mm, and with output power on the order of 100 mW. The aluminum strips constitute dipole antennas with a resonance corresponding to a highly relaxed plasmon excitation, which can be made to lie within the superconducting energy gap. Effects of excitation of the plasmon mode upon the condensate will be described. (auth)

24165 IMPROVEMENTS IN OR RELATING TO ELECTRICAL CONDUCTORS. Woolcock, Alan; McDougall, Ian Leitch; Barber, Anthony Clifford (to Imperial Metal Industries (Kynoch) Ltd.). British Patent 1,263,518. 9 Feb 1972. Filed 2 Sep 1969.

The method described for production of composite superconductors is claimed to be simpler than methods hitherto employed. The superconductor comprises a number of longitudinally extending filaments of superconducting material embedded in, and in thermal and electrical contact with, a ductile normal material. The latter is provided with grooves, with closed mouths, to accommodate the superconducting filaments. The filaments are preferably in groups held together and embedded in a wire of ductile

normal material, and some of the grooves may be provided with a reinforcing wire. The grooves are peripheral and extend towards the longitudinal axis of the assembly. Several alternative assemblies are described. (UK)

24166 JOSEPHSON EFFECT DEVICES AND LOW-FREQUENCY FIELD SENSING. Zimmerman, J. E. (National Bureau of Standards, Boulder, Colo.). Cryogenics; 12: No. 1, 19-31(Feb 1972).

Three major areas of application of the Josephson effect in superconductivity are recognized: absolute standards, millimetre and submillimetre wave sensing, and dc and low-frequency current, voltage, and magnetic field sensing. In the latter area, single-junction rf-biased low-inductance loop devices in a number of different forms (junction types and loop geometries) have been developed with sensitivities of the order of 10^{-15} T (10^{-11} G) or 10^{-19} V. These sensors are being used in applications as diverse as magnetocardiography and absolute noise thermometry in the milli-kelvin range. As amplifiers, they are characterized by demonstrated equivalent noise temperatures of less than a few mK, and probably a few μK (theoretical). Highly reliable thin-film loop devices in a number of different forms have been developed in several laboratories, but the more easily-made point-contact devices are probably the most widely used. Many of the characteristics of the devices can be easily interpreted with the aid of a pendulum analogue. (auth)

24167 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTORS. Woolcock, Alan; Barber, Anthony Clifford (to Imperial Metal Industries (Kynoch) Ltd.). British Patent 1,261,597. 26 Jan 1972. Filed 19 Jun 1969.

Superconductor assemblies provided with a passage for cooling fluid are described. It is claimed that the assemblies can be readily manufactured in substantially longer lengths than successfully achieved by earlier methods. Full constructional details are given. (UK)

24168 NONMAGNETIC IMPURITIES WITH PARTIALLY FILLED d- OR f-ELECTRON SHELLS IN SUPERCONDUCTING HOSTS. Huber, John G. San Diego, Calif.; Univ. of California (1971). 131p. University Microfilms Order No. 72-4021.

Thesis.

Results of superconducting transition temperature, T_c, measurements at pressures from zero to over 20 kbar on samples from alloy systems of Ce, U, and Mn impurities in various hosts are presented. For all systems at any pressure, T_c plotted against impurity concentration, n, is fitted excellently by the function $T_c = T_{c_0} \exp[-An/(1-Dn)]$ where T_{c_0} is the T_c of the host and A and D are adjustable parameters. This equation has recently been derived by Kaiser for the case of an impurity element with nonmagnetic Friedel–Anderson resonant electronic states dissolved in a BCS superconducting host. It is proposed that the above function holds universally for host–impurity alloy systems where the impurity ions have partially filled d- or f-electron shells with resonant states in a nonmagnetic configuration. Spin fluctuations are admissible provided their characteristic temperature, T_0, greatly exceeds T_c. The systems ThCe, ThU, and AlMn are discussed in detail, including reviews of a few of their normal-state electronic properties. ThU, like AlMn, exhibits evidence of spin fluctuations. For systems of Ce impurities in Th and Th-based alloy hosts, the variation of the parameter A was investigated as a function of (1) host fcc lattice parameter, a, and (2) average number of valence pressure, P. The logarithm of A appears to be linear both in a for fixed v and P and in P for any given system. The slope d(log A)/da is positive and independent of v. The slope d(log A)/dp is negative and similar for systems with the same v, but steepens with decreasing v. Finally, A varies considerably when v alone changes, while a and P are held constant. Reducing v increases A. Further T_c measurements are presented for alloy systems of Th (valence, 4) with Sc, Y, and Lu (valence, 3) and with Zr and Hf (valence, 4). In Th-rich fcc alloys, all five solutes raise the T_c of Th. The initial linear increases of T_c with solute concentration are grouped; the rates for Zr and Hf are about twice those for Sc, Y, and Lu. T_c peaks almost identically at around 3.8 valence electrons per atom in the systems Th–Sc, Th–Y, and Th–Lu. From T_c measurements on alloys under pressure, it is found that the addition of Sc, Y, or Lu to Th reduces the negative pressure dependence of the T_c of Th. It is implied that Sc and Lu superconduct at sufficiently high pressure with positive pressure dependence of T_c, similar to Y. For the Th–Y system, a simple linear relationship is reported in plots of $dT_c/dP|_p$ versus Y concentration. (Diss. Abstr. Int., B)

24169 HIGH-CURRENT SUPERCONDUCTIVE PRESSURE CONTACT STUDIES. Winter, J. J.; Breslin, J. T.; Gaule, G. K. (Army Electronics Tech. and Devices Lab., Fort Monmouth, N. J.). J. Appl. Phys.; 43: No. 3, 1226-30(Mar 1972).

Superconductive switches with a high-critical-current (100 to 200 A) capability have been shown to be practical. Materials thought most likely to be effective as high-critical-current pressure contacts were tested. The effects of oxidation, preloading at room temperature, and transverse magnetic fields on the critical-current capacity of contacts were studied. The relationship of the critical current of the junction to its normal-state resistance is investigated for Pb contacts. (auth)

24170 IMPROVEMENTS IN AND RELATING TO SUPERCONDUCTING COILS. Ross, John Sterry Hawley (to International Research and Development Co. Ltd.). British Patent 1,264,619. 23 Feb 1972. Filed 13 Jun 1968.

In the use of superconducting coils to form windings of electrical machines, it is desirable in some circumstances, e.g., in homopolar machines, to wind the coils as spaced annular disks lying in a plane perpendicular to the axis of rotation of the machine. The electromagnetic forces set up in the disk coils are greatest at places between the radially inner and outer extremities of each coil and, consequently, stress distributions occur in any radial spacers separating the disks as a result of such forces, varying from a maximum about midway along their length and tapering off to minimum values at their ends. At the same time, the area of the coils covered by the radial spacers must be kept to a minimum so that the maximum surface area is subjected to cryogenic fluid cooling. The coil assembly described comprises a number of spaced disk coils lying in substantially parallel planes and spaced from one another by spacing members that extend radially with respect to the disk coils and are spaced from each other in the circumferential direction; at least some of the spacing members are of maximum width between their ends and taper toward each end. The spacing members between successive pairs of coils may be aligned and mutually coupled by axially extending dowels. The circumferentially spaced spacing members may also be interlinked by arms extending circumferentially between their radially outer ends. (UK)

24171 PRESSURE EFFECTS IN SUPERCONDUCTORS. Boughton, R. I.; Olsen, J. L.; Palmy, C. (Eidgenoessische Technische Hochschule, Zurich). Progr. Low Temp. Phys.; 6: 163-203(1970).

The following subjects are reviewed: thermodynamics, connection with microscopic theory, experimental methods, experimental results at moderate pressures, work at very high pressures, and pressure effects in Type-II superconductors. (8 tables, 16 fig., 159 references). (M.H.R.)

24172 SUPERCONDUCTIVITY IN SEMICONDUCTORS AND SEMIMETALS. Hulm, J. K.; Ashkin, M.; Deis, D. W.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). Progr. Low Temp. Phys.; 6: 205-42(1970).

The present state of knowledge on low-carrier-concentration superconductors is reviewed. The following topics are covered: semiconducting properties, superconducting properties, and the theoretical analyses of T_c. (5 tables, 11 figs., 90 references). (M.H.R.)

24173 SUPERCONDUCTING POINT CONTACTS WEAKLY CONNECTING TWO SUPERCONDUCTORS. De Bruyn Ouboter, R.; De Waele, A. Th. A. M. (Kamerlingh Onnes Laboratorium, Leiden). Progr. Low Temp. Phys.; 6: 243-90(1970).

The following subjects are discussed: two superconductors weakly connected by a single superconducting point contact (the ac Josephson effect), the critical current through a double point contact between two superconductors as a function of the applied magnetic field, and two superconductors weakly connected by a double point contact in the resistive–superconductive region. (23 figs., 87 references). (M.H.R.)

24174 SUPERCONDUCTIVITY ABOVE THE TRANSITION TEMPERATURE. Glover III, Rolfe E. (Univ. of Maryland, College Park). Progr. Low Temp. Phys.; 6: 291-332(1970).

The following subjects are covered: amorphous superconductors, experiments on amorphous bismuth, gallium, and lead films, fluctuation theories; agreement with amorphous film experiments, additional experimental and theoretical results, and the critical fluctuation region. It is pointed out that the experiments convincingly demonstrate the existence of a temperature-dependent superconductivity-related contribution to the electric conductivity above the transition temperature. In favorable cases it has been detected at temperatures as high as $2T_c$. (11 figs., 81 references). (M.H.R.)

24175 THERMODYNAMIC FLUCTUATION OF THE ORDER PARAMETER IN THE VORTEX STATE OF TYPE-II SUPERCONDUCTORS. Maki, Kazumi; Takayama, Hajime (Tohoku Univ., Sendai. Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1651-65(Dec 1971).

Restricted to dirty Type-II superconductors, the effect of the

thermodynamic fluctuation of the order parameter in the vortex state is studied. The fluctuation propagator for the order parameter in the vicinity of the upper critical field is determined for all temperatures. The space average of the fluctuation diverges logarithmically in an infinite system, which may imply the instability of the Abrikosov lattice. The excess electrical conductivity in the vortex state due to the thermodynamical fluctuation of the order parameter is then calculated, which diverges like $(H_{c2} - B)^{-\frac{1}{2}}$ as the induction B approaches the upper critical field. Since the coefficient of this diverging term is reasonably large, it is believed that this effect is experimentally accessible. The excess conductivity above the upper critical field, where the anomalous term (or the Maki term) is rather important, is also discussed briefly. (auth)

24176 USE OF H_{c2} TO DETERMINE THE TEMPERATURE DEPENDENCE OF THE SPIN-FLIP SCATTERING IN A KONDO SUPERCONDUCTOR: LaCe. Chaikin, P. M. (Univ. of Pennsylvania, Philadelphia); Milhalisin, T. W. Solid State Commun.; 10: No. 5, 465-9(1 Mar 1972).

The upper critical field was measured for LaCe and LaGd and the temperature dependence of the spin-flip scattering time was determined using multiple pairbreaking theory. Further applications of this technique are presented. (auth)

24177 INSTABILITIES IN TRANSITION CURVE OF CURRENT-CARRYING ONE-DIMENSIONAL SUPERCONDUCTORS. Meyer, J.; Minnigerode, G. v. (Univ., Cologne). Phys. Lett.; 38A: No. 7, 529-30(27 Mar 1972).

Voltage steps were observed as well in the transition curve as in the voltage–current characteristic of current–carrying thin wires and whiskers of tin. These steps occur without hysteresis and their heights rise linearly with the current. (auth)

24178 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THORIUM. Fertig, W. A.; Moodenbaugh, A. R.; Maple, M. B. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 38A: No. 7, 517-8(27 Mar 1972).

The pressure dependence of the superconducting transition temperature of thorium metal to 160 kbar is reported. (auth)

24179 CRITICAL BEHAVIOR OF ONE-DIMENSIONAL SUPERCONDUCTORS: AN EXACT SOLUTION. Gruenberg, L. W. (Massachusetts Inst. of Tech., Cambridge); Gunther, L. Phys. Lett.; 38A: No. 7, 463-4(27 Mar 1972).

Using a path integral technique, the thermodynamic behavior of a 1-dimensional superconductor in the critical region is determined by the solution of the Schroedinger equation of a 2-dimensional anharmonic oscillator. Numerical integration yields the specific heat and coherence length. (auth)

24180 IMPROVEMENTS IN AND RELATING TO SUPERCONDUCTING COILS. Ross, John Sterry Hawley (to International Research and Development Co. Ltd.). British Patent 1,265,302. 1 Mar 1972. Filed 13 Jun 1968.

Reference is made to coils forming superconducting windings of electrical machines, such as homopolar machines. In such machines it is common practice to form the winding on a cylindrical former of stainless steel and enclose the coil and former in a channel-shaped housing that, together with the former, forms a complete toroidal enclosure for the coil. The space surrounding the coil is filled with a cryogenic fluid and, as a result of differential contraction between the coil and former, stresses are set up in the former, especially at the junction between it and the housing. The object of the construction described is to provide means to reduce such stresses. Metal packing strips of arcuate cross section and extending parallel to the axis of the coil are located between the coil and former; these deflect when the coil contracts and reduce the stresses on the former. The strips provide passages between the coil and the former for cryogenic fluid. (UK)

24181 HIGH RESOLUTION MAGNETO-OPTICAL STUDIES OF THE INTERMEDIATE STATE IN THIN FILM SUPERCONDUCTORS. Huebener, R. P. (Argonne National Lab., Ill.); Kampwirth, R. T.; Rowe, V. A. Cryogenics; 12: No. 2, 100-8 (Apr 1972).

The structure of the intermediate state in superconducting lead films was investigated as a function of magnetic field and film thickness. The detection system utilized the high specific Faraday rotation in thin films of a mixture of EuS and EuF_2 in combination with a polarizing microscope, yielding a resolution of about 1 μm. The thickness of the Pb films ranged between 0.7 and 9 μm, thus including the critical thickness at which the transition from the intermediate state to the vortex state occurs. At low fields, a liquid-like mixed state of multi-quanta flux tubes was observed which appeared to be stable up to increasing magnetic fields with decreasing film thickness. The diameter of these flux tubes varied approximately with the square root of the film thickness. At intermediate fields, the intermediate state pattern was found to persist down to a film thickness of 0.7 μm, the smallest thickness investigated. The periodicity length of the intermediate-state structure was in reasonable agreement with the nonbranching model of Landau. Just below H_c, small superconducting domains were observed in increasing field, whereas long threads of superconducting material were formed abruptly in decreasing field. These superconducting threads were absent in the specimens thinner than 1 to 2 μm, being replaced by a liquid-like mixed state of superconducting tubes. After the passage of a sufficiently high electrical current through the specimen, the flux structure was found to be rearranged into long domains oriented predominantly perpendicular to the current, leading to current hysteresis effects. Finally, some dynamic observations were made during current-induced flux flow. (auth)

24182 DETERMINATION OF LOW-FIELD CRITICAL CURRENT DENSITIES FROM MAGNETIZATION DATA FOR Nb–25 PERCENT Zr. Sutton, J.; Ward, D. A. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., D (London); 5: No. 3, 628-38(Mar 1972).

Magnetization measurements are used to determine low-field critical current densities of superconductors. Analysis is based on a critical-state model and takes into account magnetic field discontinuities at the surface of the specimen. The analysis was applied to cold-drawn Nb–25% Zr wires that had been subjected to a range of heat treatments. Results are compared with direct measurements of the critical currents of wires. (auth)

24183 AC LOSS AND FLUX INSTABILITIES IN SINGLE-COMPONENT AND DOUBLE-COMPONENT TYPE II SUPERCONDUCTORS. Melville, P. H. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., D (London); 5: No. 3, 613-27(Mar 1972).

Calculations are presented for ac loss and flux instabilities under ac and dc conditions in Type-II superconductors in fields that are greater than H_{c1} but not so large that surface currents, the annihilation energy of fluxons and other effects associated with H_{c1} can be neglected. The calculations are particularly relevant to the design of ac power transmission cables, and attention is paid to a two-component superconductor (e.g., a Nb/high-field superconductor) under fault conditions, that is, with current flowing in both the niobium and the high-field superconductor. In general, inclusion of surface currents and other effects associated with a finite value of H_{c1} leads to a decrease in the ac loss and a decrease in the probability of flux jumping. It is also shown that the energy of annihilation of fluxons is only important for flux jumping when the peak field is less than about $2H_{c1}$. It is the stored energy in the flux distributions that gives more flux jumping with ac than with dc. In the two-component superconductor an abrupt change in flux occurs when the flux density at the boundary between the two materials falls to zero. This gives larger losses than the equivalent superconductor without the niobium layer, and makes flux jumping more likely. (auth)

24184 DENSITY OF STATES OF SUPERCONDUCTORS WITH OVERLAPPING BANDS. Fal'ko, I. I.; Fal'ko, V. L. (Kharkov State Univ.). Solid State Commun.; 10: No. 5, 409-11(1 Mar 1972).

Interband pairing between electrons in a two-band superconductor leads to the formation of a density of states characterized by four singularities vs energy. (auth)

24185 NEW METHOD OF MEASURING THE AXIAL FIELD DISTRIBUTION IN A SUPERCONDUCTING ELECTRON LENS BY MEANS OF THE FARADAY EFFECT. Dekker, H. (Delft Univ. of Tech., Netherlands). J. Phys., E (London); 5: No. 4, 368-72 (Apr 1972).

To obtain an axial field distribution desirable for an electron microscope objective, i.e., with high peak intensity and small half-width, use was made of the flux-shielding property of hollow superconducting cylinders. Two cylinders, separated by a gap, were coaxially arranged in the bore of a superconducting solenoid. An apparatus is described in which the axial field distribution in the lens can be measured using the Faraday effect in cerium phosphate glass at 4.2°K. In this glass, the Faraday rotation is large at low temperatures and proportional to the magnetic field. The measured field distribution is compared with that obtained from a resistor network and from a computer. The agreement was satisfactory. With the computer program, the most important electron optical quantities were calculated. Lens defects due to ellipticity and misalignment of the cylinders are discussed. The results are promising especially for high-voltage electron microscopy. (auth)

24186 PRELIMINARY STUDIES OF SUPERCONDUCTING ALTERNATORS. Harrowell, R. V. (Central Electricity Research Labs., Leatherhead, Eng.). Cryogenics; 12: No. 2, 109-15(Apr 1972).

The possibilities of using superconductors in alternators are discussed. The advantages and disadvantages are assessed for first a machine with a rotating superconducting winding, then a machine with a stationary superconducting winding and rotating armature, and finally a machine with both a superconducting reciprocating armature and a superconducting field winding. A model of this final type of machine constructed at CERL is briefly described. (auth)

24187 STUDY OF THE PROPAGATION OF THE NORMAL REGION IN A SUPERCONDUCTING SOLENOID. Cesnak, L.; Kokavec, J. (Electrotechnical Inst., Bratislava). Cryogenics: 12: No. 2, 116-20(Apr 1972).

An absolutely reliable piece of equipment for the removal of the energy from a small nonstabilized superconducting solenoid is described. The equipment is based on the detection of the normal region using a closely wound auxiliary winding. A thyristor (SCR) interrupts the current after quenching. The experiments performed with the quenching of the coil showed the influence of the heat pulse, the thermal history of the winding, and the time during which the current was switched off, on the character of the propagation of the normal region. (auth)

24188 ANALOG SIMULATION OF A JOSEPHSON JUNCTION. Hamilton, C. A. (Univ. of Rochester, N. Y.). Rev. Sci. Instrum.; 43: No. 3, 445-7(Mar 1972).

An analog model that uses inexpensive integrated circuits to simulate the properties of a Josephson junction is described. The circuit automatically eliminates cumulative error and thus can operate in a continuous mode. The model is useful as a demonstrator and in analyzing the behavior of a Josephson junction in a complex circuit. (auth)

24189 THEORY OF CLEAN TYPE-II SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS WITH PARTICULAR REFERENCE TO THE ULTRASONIC ABSORPTION RATE. Scharnberg, Kurt (Univ., Hamburg). J. Low Temp. Phys.; 6: No. 1-2, 51-68(Jan 1972).

It is shown that the method used by Brandt, Pesch, and Tewordt to solve the Gor'kov equations leads to a physically unacceptable result for the ultrasonic absorption rate in the clean limit. To account for this failure the semiclassical approximation was examined. It was found that this approximation strongly influences the general structure of the Green's functions. In particular, it introduces an apparent quasi-particle damping, which can be considered the origin of the difficulties mentioned above. An alternative treatment of the Gor'kov equations including quantized Landau levels is outlined. From the general expression for the ultrasonic absorption rate in a superconductor in the vortex state the expression describing the giant quantum oscillations is rederived. (auth)

24190 INFLUENCE OF THE FORM OF THE PHONON SPECTRUM ON THE TRANSITION TEMPERATURE OF SUPERCONDUCTORS. Geilikman, V. T.; Masharov, N. F. (State Committee of Standards, Moscow). J. Low Temp. Phys.; 6: No. 1-2, 131-9(Jan 1972).

The influence of the form of the phonon spectrum on the superconducting transition temperature under the usual pairing mechanism is investigated. The coupling constant λ, which determines T_c in the two-phonon-peak and acoustic-dispersion models, is calculated and its dependence on the usual coupling constant and other parameters is determined. It is shown that the maximum possible value of λ is unity. An expression is derived for T_c, making it possible to find the exact numerical value of the coefficient of the exponential function for any form of phonon spectrum. (auth)

24191 SUPERCONDUCTIVITY AT HIGH PRESSURE IN THE A15 COMPOUNDS. Smith, T. F. (Univ. of California, San Diego, La Jolla). J. Low Temp. Phys.; 6: No. 1-2, 171-95 (Jan 1972).

The superconducting transition temperature for a number of A15 compounds was determined as a function of hydrostatic pressure up to 25 kbar. The observed pressure dependences are compared with the predictions of a number of correlations between T_c and volume derived from zero-pressure data. The limitations of the theoretical models used to calculate T_c for the transition metals and their alloys when applied to a description of the pressure dependence are discussed. (auth)

24192 MAGNETIC PERMEABILITY OF TYPE-II SUPERCONDUCTORS. de Klerk, D.; van der Klein, C. A. M. (Univ., Leiden). J. Low Temp. Phys.; 6: No. 1-2, 1-33(Jan 1972).

A number of simple models are discussed for the magnetic permeability behavior of type-II superconductors. It turns out that the London–Bean model extended with a surface barrier as discussed by Ullmaier and by Wipf, though it gives a satisfactory description of the alternating current losses, fails as soon as the real part of the permeability is also taken into account. It proves to be possible, however, to give a different extension to the London–Bean model consisting of a surface layer without pinning. This model is in satisfactory agreement with the experimental data. (auth)

24193 ACOUSTICAL PLASMONS, PHONON ANOMALIES, AND SUPERCONDUCTIVITY IN TRANSITION-METAL SYSTEMS. Ganguly, B. N. (Univ. of Illinois, Urbana); Wood, R. F. Phys. Rev. Lett.; 28: No. 11, 681-4(13 Mar 1972).

It is shown that the concept of acoustical plasmons may be useful for understanding the anomalous behavior of the phonon dispersion curves of superconducting transition-metal systems with high T_c (5 to 10°K). The value of the velocity of plasmon sound obtained from the phonon calculations for Nb is quite close to that needed to explain the specific-heat anomaly by the acoustical-plasmon mechanism. (auth)

24194 ANALOG OF THE dc JOSEPHSON EFFECT IN SUPERFLUID HELIUM. Hulin, J. P.; Laroche, C.; Libchaber, A.; Perrin, B. (Ecole Normale Superieure, Paris). Phys. Rev., A; 5: No. 4, 1830-9(Apr 1972).

An experiment is described in which the flow of helium through a 20-μ orifice connecting two helium baths is studied. Closed capacitors are used to measure the helium level. Flow-gravitational-head difference characteristics are traced for various temperatures from 1.15 to 2.26°K. Subcritical and supercritical flow are clearly observed, and the effect of temperature on the relation between the chemical potential and the level difference is discussed. Abrupt appearance of supercritical flow is observed. With a quartz transducer placed in front of the coupling hole, a decrease and subsequent increase of the flow velocity with quartz voltage is measured. (auth)

24195 SUPERCONDUCTOR MAGNET COILS. (to Siemens Aktiengesellschaft). British Patent 1,262,902. 9 Feb 1972. Priority date 7 May 1968, Germany.

The coil consists of a plurality of superconductor winding layers arranged between successive pairs of adjacent winding layers so as to maintain between them channels for a coolant. Each winding layer has one, but not both, of its inner and outer surfaces bounding the channels. (M.C.G.)

24196 THEORY OF METAL WEAKENING DURING A SUPERCONDUCTING TRANSITION. Natsik, V. D. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2540-53(Dec 1971). (In Russian).

A theory is developed of metal weakening effects that had been observed experimentally on transition to the superconducting state and which consist in a noticeable increase of plasticity of the metals. The case of not-very-large stresses is considered. For such stresses the plastic deformation rate is determined by thermally activated motion of the dislocations through a set of potential barriers produced in the crystal by various structural defects. It is shown that the mean time required for overcoming the barrier significantly depends on the electron retardation force of the dislocation. As a result, a sharp change of the force during the superconducting transition leads to a change in the kinetics of the plastic deformation. Weakening effects are analyzed for various deformation conditions created experimentally for active deformation with a constant rate, creep, and stress relaxation. The temperature dependence of the effects is investigated and compared with the experimental data. (auth)

24197 RUTHENIUM BASED ALLOYS. (to Siemens Aktiengesellschaft). British Patent 1,264,298. 16 Feb 1972. Priority date 14 Aug 1969, Germany.

The preparation of alloys of the composition $(Ce_{1.00-x}A_x)Ru_2$ where A is one of the elements Tb, Dy, and Ho, and where $0.10 \leq x \leq 0.24$ for Tb, $0.12 \leq x \leq 0.27$ for Dy, and $0.10 \leq x \leq 0.28$ for Ho is reported. These alloys exhibit both superconductive and ferromagnetic properties at low temperature. The alloys are Type-II superconductors with a lower critical magnetic field H_{c1} and an upper critical magnetic field H_{c2}. (D.H.M.)

24198 NATURE OF SUPERCONDUCTING NIOBIUM AND TANTALUM MONOCARBIDES. Dubrovskaya, L. B.; Rabin'kin, A. G.; Gel'd, P. V. (Inst. of Chemistry, Sverdlovsk, USSR. Affiliate Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 300-6(Jan 1972). (In Russian).

The transition temperatures to the superconducting states T_c of cubic niobium and tantalum carbides in their homogeneity regions were measured. The electron-state band density at the Fermi level $N_0(\epsilon_F)$ and the electron–phonon interaction parameter V_{ep} were calculated on basis of the T_c values and electron specific heats γ cited in the literature. The calculations were performed within the framework of the strong pairing theory. It is shown that the variation of T_c depends on both the decrease

of $N_0(\epsilon_F)$ and V_{ep} with increase of concentration of the carbon vacancies in the carbides investigated. The results are employed, together with data on the concentration–temperature dependences of the magnetic susceptibility, for discussion of the electron-structure peculiarities of cubic carbides of the Va subgroup transition metals. (auth)

24199 SUPERCONDUCTIVITY OF BISMUTH, BARIUM, AND LEAD AT PRESSURES EXCEEDING 100 KBARS. Il'ina, M. A.; Itskevich, E. S.; Dizhur, E. M. (Inst. of Physics of High Pressures, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2357-61(Dec 1971). (In Russian).

The $T_c(P)$ dependences were studied for high-pressure modifications of bismuth, barium, and lead existing in the range 100 to 200 kbar. (auth)

Equipment and Devices

24200 (CERN-72-3) CRYOSTAT FOR THE EXPERIMENTAL OPTIMIZATION OF VERY LOW PRESSURE CONDENSATION CRYOPUMPING. Benvenuti, C. (European Organization for Nuclear Research, Geneva (Switzerland)). 26 Jan 1972. 12p. Dep. NTIS (U. S. Sales Only).

The observed deviation of the hydrogen saturated vapor pressure (S.V.P.) from the Clausius–Clapeyron law below about 3°K, resulting in a temperature-independent pressure limitation, might greatly reduce the usefulness of condensation cryopumping. This deviation was found to depend on the characteristics of the experimental apparatus, namely the nature of the condensing surface and of the thermal radiation reaching it. The project and the performance of a cryostat permitting an easy change of the condensing surface and a variation of the quantity and of the spectrum of the radiation load are presented here, hence a complete investigation on the physical features of this deviation is made possible. (auth)

24201 (RHEL/R-236) CONTINUOUS REFRIGERATION AT 1.8°K IN LABORATORY CRYOSTATS USING A 4.2°K LIQUID HELIUM DEWAR SUPPLY. Smith, W. T. (Rutherford High Energy Lab., Chilton (England)). Oct 1971. 8p. Dep. NTIS (U. S. Sales Only). UK 13 pence.

The production of 1.8°K liquid using 4.2°K liquid from the standard helium dewars incurs large liquid losses. The proposed scheme considerably reduces these losses and can provide continuous refrigeration in the region of 1.8°K for laboratory cryostats. A potential 45% improvement in 1.8°K liquid production is feasible. (auth)

24202 OPERATION OF SUPERCONDUCTING MAGNETS AT TEMPERATURES BELOW 4.2 K. Biltcliffe, M. N. (Oxford Instrument Co.); Hanley, P. E.; McKinnon, J. B.; Roubeau, P. Cryogenics; 12: No. 1, 44-7(Feb 1972).

Tests on three different laboratory-scale superconducting magnets wound from NbTi superconductors were made to investigate the enhancement of quench fields on cooling below 4.2K. The enhancement was up to 25% at 2K. A method of cooling the coils without pumping on the helium bath, which enables the cryostat to be refilled with liquid helium without raising the temperature, is also described. (auth)

24203 LOW POWER, HIGH STABILITY, SUPERCONDUCTING MODULATOR. Allnutt, J. G. (Univ. of Sussex, Brighton, Eng.); Walton, A. J. J. Phys., E (London); 5: 131-2(Feb 1972).

A simply constructed high-stability superconducting modulator requiring a power of 3 mW and capable of detecting 5 pV is described. (auth)

24204 FUTURE OF SUPERCONDUCTIVITY AND RESISTIVE CRYOGENICS FOR POWER TRANSMISSION SYSTEMS. Boesenberg, E. H.; Zanona, A. (Commonwealth Edison Co., Chicago). Proc. Amer. Power Conf.; 33: 980-8(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Research being done on resistive-cryogenic or superconducting cables is briefly reviewed; models of proposed systems utilizing these cables are discussed. It is concluded that: (1) high-capacity underground systems will be required to meet future load demands; (2) line capacities will be dictated by generator sizes; (3) compressed-gas-insulated cables may well fill the system requirements to the early 1990s; (4) economics rather than loadings will determine which cable, resistive-cryogenic or superconducting, that will be used for loads in excess of 2500 MVA; and (5) both types of cable systems are technically feasible. (L.M.T.)

24205 METHOD OF SPLICING SUPERCONDUCTIVE MATERIALS. Kinter, Malcolm L.; Weissman, Ira (to Varian Associates). British Patent 1,262,994. 9 Feb 1972. Priority date 4 Jun 1968, United States.

A method of splicing two portions of high-field compound superconducting material is described. A layer of particulated material containing the constituent element of a high-field compound superconductor is sandwiched between the two portions compacting the particulated material together into intimate contact with the two portions. The compacted material is heated in place between the two portions to form a high-field compound superconducting splice therebetween. (M.H.R.)

24206 INTERNATIONAL PRACTICAL TEMPERATURE SCALE OF 1968. Durieux, M. (Kamerlingh Onnes Laboratorium, Leiden). Progr. Low Temp. Phys.; 6: 405-25(1970).

The following topics are covered: international practical temperature scales, the International Practical Temperature Scale of 1948(IPTS-48), the International Practical Temperature Scale of 1968(IPTS-68), the accuracy and reproducibility of the IPTS-68, the vapor pressure-temperature relations of O_2, N_2, Ne, and H_2, differences between the IPTS-68 and other temperature scales, the 1958 ^{4}He scale and the 1962 ^{3}He scale, and the range from 5.189°K to 13.81°K. (55 references). (M.H.R.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 24635, 24653–24654, and 24976.

24207 (AERE-M-2474) NERMA: A PROGRAMME FOR EVALUATING NEUTRON INDUCED ENERGY RELEASE IN MATERIALS. Blow, S. (Atomic Energy Research Establishment, Harwell (England)). Nov 1971. 19p. Dep. NTIS (U. S. Sales Only), UK 17p.

NERMA is a code written in IBM System/360 FORTRAN IV for calculating the energy released in materials by a flux of neutrons passing through them. The program evaluates (a) the kinetic energy released via charged-particle production and nuclear recoil; (b) the amount of energy released as γ radiation; and (c) the spectrum of the γ-ray source in selected regions. The γ-ray source intensity and spectrum output from NERMA may be cast in a form suitable for use as input in tracking the transport and energy deposition of this γ radiation. A statement is given of the nuclear data input requirements, the logic of operation of NERMA, the problem data input format, and test case input layout and results. (auth)

24208 (KFKI-71-78) PREPARATION OF GROUP CONSTANTS FOR NEUTRON SHIELDING CALCULATIONS FROM THE EVALUATED NUCLEAR DATA AVAILABLE FROM IAEA. Vertes, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 6p. Dep. NTIS (U. S. Sales Only).

The program ZEBRA-2 is used to produce a group-constant set with a more adequate group scheme than that previously used for neutron shielding calculations. The input scheme for ZEBRA-2 is given, and the program is tested by calculating the fast neutron spectra transmitted through graphite and iron. (J.F.P.)

24209 ANALYSIS OF NEUTRON WAVES IN FINITE POLYCRYSTALLINE MEDIA. Utsuro, Masahiko (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 103-12(Feb 1972).

A simple analysis is presented concerning the total response observed in neutron wave experiments under conditions outside the asymptotic-mode region in finite polycrystalline media. A discontinuity of the pseudo-fundamental eigenvalue due to sub-Bragg neutrons and the disappearance of the cold-neutron dominated discrete eigenvalue are indicated in the low-frequency region in finite polycrystalline media under ordinary experimental conditions. The analytically continued dispersion relation cannot explain the space- (or time-) dependent and system dimension-dependent experimental results in the pseudo-fundamental mode region. Here, the total solution including such contaminating components as the sub-Bragg neutron continuum or the spatial higher mode is obtained in an integral making use of suitable models and simple approximations. The portion having the largest excitation amplitude in the solution is analyzed by a saddle-point method applied to the integral, and a simple relation for the effective relaxation coefficient observed in the experiment is derived. Numerical calculations give satisfactory agreement with experimental results in graphite, and the experimental conditions desirable for the exact observation of the pseudo-fundamental eigenvalue are discussed as well as practical results obtained for graphite. (auth)

24210 METHOD OF PRODUCING NEUTRON SOURCE TUBE WITH COATED TARGET. Noble, Lowell A. (to Varian Associates). U. S. Patent 3,640,597. 8 Feb 1972. Filed 6 Jan 1964.

A method of making an active metal target for a neutron source tube is described. Deuterium or tritium gas is sorbed into the active metal. The target is then heated and reacted with a coating gas to form a protective coating over the target which prevents desorbtion of the deuterium or tritium during operation of the tube. (auth)

24211 NEW THEORETICAL AND EXPERIMENTAL METHODS FOR STUDY OF NEUTRON THERMALIZATION. Purica, I. I. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: No. 4, 365-408(1970). (In Rumanian).

The behavior of neutrons in finite media is described by the Boltzmann equation. A general model and experimental methods for the study of neutron thermalization are presented. The frequency characteristic method is discussed in some detail: topics include the theory of linear systems and neutron gas behavior in finite media, pulse and frequency characteristics of a neutron gas in finite media, information obtainable by the frequency characteristic method, and neutron waves as a first approximation to a Poisson sum of the frequency characteristic method. The experimental techniques used in the frequency characteristic method and the accuracy of the method are described as applied to the subcritical assembly and the modulated source, as well as the system for neutron flux analysis. The separation of the eigenvalues λ_{00} and λ_{10} in graphite through the use of the frequency characteristic method is presented; theoretical considerations on the possibility of separating the eigenvalues are discussed, and experimental results are given. (8 figures, 4 tables, 58 references) (R.W.R.)

24212 LOW ENERGY NEUTRON INTERACTIONS WITH URANIUM CARBIDE. Lajeunesse, C.; Moore, W. E.; Yeater, M. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng.; 47: No. 3, 349-64(Mar 1972).

The double-differential scattering cross section of polycrystalline natural uranium carbide (UC) was measured for incident energies of 0.092, 0.135, and 0.159 eV. Inelastic scattering peaks corresponding to excitation energies of 0.013 and 0.045 eV were observed and are shown to belong to acoustic and optical modes of the UC lattice. A model was developed using a normal mode analysis based on the Born and Von Kármán approximation, including noncentral forces and considering up to third-nearest neighbors. A theoretical scattering law was derived based on this analysis. Resolution and multiple scattering effects were calculated using a new Monte Carlo approach. After the application of these corrections, the double differential cross sections derived from the theoretical scattering law agree with the measurements. The variation of the specific heat with temperature is accurately predicted by the model. The total cross section was also measured for the energy range 0.006 to 3.5 eV. The Bragg peaks due to coherent scattering were resolved up to 0.05 eV. The total cross section calculated from our noncentral force model compares well with this measurement. (auth)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstract 24722.

24213 (BMBW-FBK-71-20) APPLICATIONS OF THE THEORY OF THE SYMMETRIC GROUP TO STATES AND REACTIONS OF THE LIGHTEST NUCLEI. John, G. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Dec 1971. 142p. (In German). Dep. NTIS (U. S. Sales Only).

The theory of the symmetric group in the framework of the nuclear cluster model is used for calculations of nuclear properties. The analysis is applied to bound states and mainly to nuclear reactions. For the system of four nucleons, the necessary tools of group theory are developed. These tools are then employed for investigating the excited states of ^{4}He and the deuteron-deuteron-reaction. (auth)

24214 (ORNL-TM-3635) CALCULATION OF GAMMA-RAY PRODUCTION AND TRANSPORT IN LIQUID NITROGEN. Straker, E. A.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). 16 Dec 1971. 23p. Dep. NTIS.

The gamma rays produced by neutron collisions with nitrogen comprise the major component of the secondary gamma-ray dose in air. To determine the adequacy of gamma-ray production cross sections, calculations using the ENDF/B material 506 version of neutron and gamma-ray cross sections for nitrogen are compared to results of a secondary gamma-ray measurement made at Gulf General Atomic for a 14-MeV neutron source in a very large nitrogen dewar. (auth)

24215 NEW ^{4}He LEVELS AND THE DIFFERENCE IN ANGULAR DISTRIBUTIONS FOR THE REACTIONS D(d,n)^{3}He AND D(d,p)^{3}H. Sergeev, V. A. (Nuclear Research Inst., Moscow). Phys. Lett.; 38B: No. 5, 186-8(6 Mar 1972).

New T = 0 states of ^{4}He with small nucleon widths are suggested on the basis of theoretical arguments. The difference in angular distributions for the d–d reactions is found to be due to Coulomb mixing of the new and earlier known odd-parity states. (auth)

24216 INFLUENCE OF THE LONG-RANGE CLUSTERING CORRELATIONS IN THE ^{4}He GROUND STATE, ON THE PHOTOREACTION ^{4}He + $\gamma \rightarrow$ d + d. Guiasu, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 10, 1107-12(1971).

The influence of the long-range clustering correlations in the ^{4}He ground state on the photoreaction ^{4}He + $\gamma \rightarrow$ d + d is studied. The theoretical results are surprisingly good, an interpolation between the low-energy (below 40 MeV) and high-energy (above 200 MeV) experimental data being achieved. (1 figure, 1 table) (auth)

24217 CHARGE-ASYMMETRY EFFECTS IN THE REACTION $^2H(^4He,^3He)^3H$. Gross, E. E.; Newman, E.; Greenfield, M. B.; Rutkowski, R. W.; Roberts, W. J.; Zucker, A. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 5: No. 3, 602-8 (Mar 1972).

Differential cross sections for the process $^2H(^4He,^3He)^3H$ are presented for ^4He beam energies of 82.1, 64.3, and 49.9 MeV. The measurements were made to test the Barshay–Temmer theorem, which requires ^3H and ^3He yields to be independently symmetric about 90° c.m. A pronounced deviation from 90° c.m. symmetry, which is angle- and energy-dependent, was found. A distorted-wave Born-approximation analysis assuming the reaction mechanism to be a simple $l = 0$ nucleon-pickup process can qualitatively account for the observed deviations. (5 figures, 1 table) (auth)

24218 ANALYSIS OF THE (p,2p) REACTION ON DEUTERIUM AT 600 MeV. Wallace, Jon M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., C; 5: No. 3, 609-14(Mar 1972).

A calculation of the differential cross section $(d\sigma/dEd\Omega^2)$ for the D(p,2p) process at 600 MeV was carried out using as input the available nucleon–nucleon elastic scattering data and a model deuteron wave function. The calculation includes Glauber double-scattering and final-state-interaction corrections to the plane-wave impulse approximation (PWIA). The calculation agrees favorably with the recent D(p,2p) experimental data at most residual neutron recoil momenta and is an improvement over the earlier PWIA analysis. The recently proposed D* component of the deuteron appears to be unimportant in reactions of this kind. (auth)

24219 RADIATIVE np CAPTURE AND POLARIZATION EFFECTS. Adler, Ronald J. (American Univ., Washington, D. C. Stanford Linear Accelerator Center, Calif.). Phys. Rev., C; 5: No. 3, 615-25(Mar 1972).

For many years a 10% discrepancy has existed between theory and experiment for the total radiative thermal np capture cross section. This process is usually considered to be dominated by a $^1S \rightarrow d$ transition. Breit and Rustgi have shown that a significant amount of $^3S \rightarrow d$ transition would be detectable in experiments with polarized n and p. It is shown here that the $^3S \rightarrow d$ transition can be described with a general transition current containing two parameters. On the assumption that the amplitude is large enough to explain the discrepancy, angular distributions are found for the γ-ray emission from polarized n on polarized p. On the other hand, theoretical values calculated for the parameters indicate that the $^3S \rightarrow d$ transition is probably not large enough to explain the discrepancy; the correctness of the theory is discussed. (5 figures, 1 table) (auth)

24220 POLARIZATION MEASUREMENTS AND ANALYSIS IN $n-^4He$ SCATTERING FROM 11.0 TO 30.3 MeV. Broste, W. B. (Los Alamos Scientific Lab., N. Mex.); Mutchler, G. S.; Simmons, J. E.; Arndt, R. A.; Roper, L. D. Phys. Rev., C; 5: No. 3, 761-7(Mar 1972).

Measurements of the polarization function $P(\theta)$ in $n-^4He$ scattering were made at neutron energies of 11.0, 17.7, 23.8, 25.7, 27.3, and 30.3 MeV with the aim of improving upon previous descriptions of the interaction, especially as regards the analyzing power. Significant differences were found at the higher energies between experimental values for $P(\theta)$ and predictions of previously existing $n-^4He$ scattering phase shifts. The new polarization data were used with published $n-^4He$ cross-section and polarization data in a series of single-energy phase-shift searches in an attempt to provide an improved set of phase shifts above 20 MeV. (2 figures, 4 tables) (auth)

24221 n–D ELASTIC SCATTERING AND POLARIZATION CALCULATIONS WITH TENSOR FORCE AND p-WAVE INTERACTION. Doleschall, P. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 38B: No. 5, 298-300(6 Mar 1972).

Three-body calculations for n–d elastic scattering are performed at $E_n = 14.1$ MeV with s- and p-wave N–N interactions and a tensor force. The tensor force is not able to reproduce even the order of magnitude of the elastic neutron polarization. It is also shown that the p-wave N–N interactions have an important effect on the neutron polarization. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 23789, 23945–23946, 24240, 24254, 24257, 24284, 24369, 24371, and 25024.

24222 (FEI-272) INELASTICALLY SCATTERED NEUTRON SPECTRA AND THE DENSITY OF NUCLEAR LEVELS. Biryukov N. S.; Zhuravlev, B. V.; Kornilov, N. V.; Plyaskin, V. I.; Sal'nikov, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

Spectra of elastic and inelastic scattering of neutrons with initial energies of 9.2 ± 0.3 MeV were measured for C, Al, Cu, and Nb nuclei in a cyclotron. The time-of-flight method with ring geometry was employed. The nuclear temperature and a parameter of nuclear level density (from the Fermi-gas model) were derived from the spectra of inelastically scattered neutrons. The cross sections for elastic and inelastic neutron scattering by C, Al, Cu, and Nb were also determined. (tr-auth)

24223 (ORNL-tr-2580) CLUSTER STRUCTURE OF LIGHT NUCLEI AND LONG-RANGE ALPHA PARTICLES. Abdinov, O. B.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by F. Kertesz (Oak Ridge National Lab., Tenn.), from report JINR-P2-5939. 6p. Dep. NTIS.

Monte Carlo calculations were carried out on the long-range alpha particles from the inelastic scattering of 660-MeV protons with carbon-12 nuclei. It is found that by taking into account the decrease of the density of the number of intranuclear nucleons knocked out during an intranuclear cascade the number of high-energy alpha particles is substantially increased. The number of alpha clusters in given spherical layers and the energy spectrum and angular distribution of the emitted alpha particles are given. (J.F.P.)

24224 (ORO-3924-8) ANGULAR MOMENTUM EFFECTS IN NUCLEAR REACTIONS. Progress report, January 1–December 31, 1971. Natowitz, J. B. (Texas Agricultural and Mechanical Univ., College Station. Cyclotron Inst.). Contract AT-(40-1)-3924. 38p. Dep. NTIS.

Research performed under AEC Contract AT-(40-1)-3924 during the period 1 January 71 to 31 December 71 is summarized. Measurements were made of complete fusion cross sections for the reactions of ^{12}C and ^{14}N projectiles with ^{27}Al, Ca, ^{48}Ti, Cr, Ni and Cu targets. The use of these data to test various possible origins of an angular momentum cut off to fusion reactions is discussed. A computerized particle identification system was developed for use in a variety of nuclear reaction studies. Evaporation of alpha particles from $^{120*}Te$, formed in the reactions $^4He + ^{116}Sn$ and $^{12}C + ^{108}Pd$, is underway. Studies of the decay of neutron-deficient Am isotopes have continued with emphasis on the α decay in that region. A completed study of the variation of K_β^β with excitation energy produced no evidence for an increase in pairing energy at the saddle point in the nucleus ^{198}Hg. A search was made for long-lived fission isomers of Hg produced in the reactions of 20 to 100 MeV ^4He with Pt. Based on the total number of Pt atoms, the total cross section for production of spontaneous fission activities with half-lives in the range of 1 day to several months is $\lesssim 10^{-37}$ to 10^{-38} cm^2. A collaborative investigation of the dependence of charged particle x-ray fluorescence cross sections on projectile z has continued. A list of publications is included. (auth)

24225 EXISTING EXPERIMENTAL DATA AND THE ROLE OF MULTI-NUCLEON MECHANISM OF SLOW π^- MESON CAPTURE. Kolybasov, V. M.; Tsepov, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 4, 744-52(Oct 1971). (In Russian).

It is shown that the existing data on the spectra and angular correlations of particles produced in absorption of slow π^- mesons by ^{12}C permit a considerable contribution of the multi-nucleon (in particular, of α-particle) capture mechanism. The experiments required for reliable establishment of the role of the multi-nucleon mechanism are proposed. (auth)

24226 STUDY OF REACTION $\mu^- + ^{12}C \rightarrow ^8Li + ^3He + n + \nu$. Batusov, Yu. A.; Bunyatov, S. A.; Vartanyan, V. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 6, 1206-13(Dec 1971). (In Russian).

Negative muon capture by carbon, nitrogen, and oxygen nuclei with the ^8Li nucleus production was studied using photoemulsions. Relative probabilities of possible channels of reactions are measured. It is shown that the main channel is the μ^--meson capture by ^{12}C nucleus in reaction $\mu^- + ^{12}C \rightarrow ^8Li + ^3He + n + \nu$ with the relative probability within from $(1.1 \pm 0.2)(10)^{-3}$ up to $(1.6 \pm 0.2)(10)^{-3}$. Angular correlation analysis show that the ^3He and neutron result from disintegration of excited $^{4*}He$ nucleus from levels 22.5 ± 2 MeV. Energy spectra and angular correlations of secondary particles are compared with the calculations according to the scheme of μ^--meson capture with production of high-excited intermediate $^{12*}B$ nucleus and the capture by few-nucleon ^4Li association. (auth)

24227 ALPHA-PARTICLE UNSTABLE STATES IN ^{12}C. Fawzi, M. A. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Phys.; 250: No. 2, 120-44(1972).

Alpha particle unstable states in ^{12}C have been investigated using the three reactions $^{14}N(d,\alpha')^{12}C$, $^{14}N(d,\alpha'\alpha)^{8}Be$ and $^{12}C(\alpha,\alpha')^{12}C$. Excitation cross sections and angular distributions have been measured for the reactions $^{14}N(d,\alpha')$ at 52 MeV and $^{12}C(\alpha,\alpha')$ at 90 MeV. For a few angle pairs the α-decay of excited states in ^{12}C have been observed in $^{14}N(d,\alpha'\alpha)$ correlation measurement. The reactions selectively excite only T = 0 states. A previously undetected level with a large α-decay width (Γ = 1.2 MeV) has been observed at 15.62 MeV excitation. This level shows up clearly in both reactions and is further distinguished from the nearby 14.08 state in the correlation measurement because of the distinctly different energy distributions of the decay products. On the basis of α particle angular distributions the 15.62 MeV level was assigned spin and parity 4^+ and the level at 14.08 was assigned 3^-. The latter differs from the value suggested by earlier work. Comparison with DWBA calculations indicates that angular distributions of all other prominent levels are in agreement with their earlier assignments. Two levels at 19.20 and 20.30 MeV (both $\Gamma \simeq 0.4$ MeV) and three further levels at 21.81, 22.7 and 24.24 MeV also decay predominantly by α-emission. (auth)

24228 KNOCKOUT OF α-CLUSTERS BY HIGH-ENERGY PROTONS. Abdinov, O. B. (Inst. of Physics, Baku). Izv. Akad. Nauk, Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 6, 138-41(1970). (In Russian).

The interaction of 660 MeV protons with a carbon nucleus and the parameters of α-association, angular and energy distribution of α-particle cascades were studied. The average number of α-particles was determined as a function of the choice of parameters. Allowing for the α-clusters noticeably improved the agreement between theory and experiment in regard to cascade nucleon distribution, and energy spectrum of excitation of the residual nuclei. (K.S.W.)

24229 ROLE OF THE α + t CHANNEL IN THE COULOMB EXCITATION OF THE $\frac{1}{2}^-$ STATE IN ^7Li. Smilansky, U. (Weizmann Inst. of Science, Rehovot, Israel); Povh, B.; Traxel, K. Phys. Lett.; 38B: No. 5, 293-7(6 Mar 1972).

The role of the virtual excitation of the α + t channel in exciting the $\frac{1}{2}^-$ state in ^7Li is discussed in terms of the known properties of the α + t channel. It is shown that this effect is larger than the reorientation caused by the ground-state quadrupole moment. Existing data on the Coulomb excitation of the $\frac{1}{2}^-$ state is analyzed in terms of both the virtual breakup and the reorientation effects. The resulting Q_s and B(E2; $\frac{3}{2} \rightarrow \frac{1}{2}$) are consistent with values obtained in former measurements. (auth)

24230 TRANSITION TOROIDAL FORM FACTORS OF LIGHT NUCLEI. Bluvshtein, R. E.; Dubovik, V. M.; Cheshkov, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 1, 100-7(Jan 1972). (In Russian).

For the example of large-angle inelastic scattering of electrons on the ^9Be nucleus (transition $J^P = \frac{3}{2}^- \rightarrow \frac{1}{2}^+$) it is shown that the conventional neglect of the contribution to the cross section of inelastic scattering of transversal electric form factors is invalid as it leads to overestimated, approximately twice as large, values of higher (beginning with quadrupole) magnetic moments extracted from experiment. In the shell model with L–S coupling it is shown that contributions to the transversal cross section $\sigma_\perp$ of toroidal dipole and magnetic quadrupole form factors are comparable in order of magnitude. The total experiment for the measurement of all the form factors of transition $J^P = \frac{3}{2}^- \rightarrow \frac{1}{2}^+$ for ^9Be nucleus is discussed in detail. (auth)

24231 ANGULAR DISTRIBUTIONS OF HIGH ENERGY PHOTOPROTONS FROM $^6Li(\gamma,p)$. Weise, W. (Univ., Erlangen, Ger.). Phys. Lett.; 38B: No. 5, 301-5(6 Mar 1972).

(γ,p) angular distributions were studied for photon energies $E_\gamma \geq$ 100 MeV on the basis of a shell model modified by short-range dynamical correlations (SRC's) between the nucleons. It is shown that short-range correlations affect the magnitude as well as the shape of the proton angular distributions. It turns out that the shell model underestimates the experimental data appreciably, whereas the inclusion of SRC's tends to reproduce the measured angular distribution. (auth)

24232 SHELL-STRUCTURE EFFECT ON ELASTIC α SCATTERING. Oeschler, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Schroeter, H.; Fuchs, H.; (and others). Phys. Rev. Lett.; 28: No. 11, 694-7(13 Mar 1972).

Back-angle enhancements of elastic α-scattering cross sections was observed for nuclei at the ends of the 1p, 2s–1d, and $f_{\frac{7}{2}}$ shells. Strong reduction of this enhancement occurs if excess neutrons enter the next open major shell. The results are discussed in terms of intermediate α structure. (auth)

24233 FRAGMENTATION OF ^{14}N NUCLEI AT 2.1 GeV PER NUCLEON. Heckman, Harry H.; Greiner, Douglas E.; Lindstrom, Peter J.; Bieser, Frederick S. (Univ. of California, Berkeley). Science; 174: No. 4014, 1130-1(10 Dec 1971).

An experiment was carried out at the Bevatron on the nuclear fragmentation of ^{14}N ions at an energy of 2.1 billion electron volts (GeV) per nucleon. Because of the near equality of the velocities of the ^{14}N beam and the fragmentation products at an angle of 0°, it is possible to identify the nuclear fragments isotopically. (3 figures) (auth)

24234 STUDY OF THE REACTIONS $^{16}O(^6Li,^3He)^{19}F$ and $^{16}O(^6Li,t)^{19}Ne$ AT E(^6Li) = 24 MeV. Garrett, J. D.; Bingham, H. G.; Fortune, H. T.; Middleton, R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 5: No. 3, 682-90(Mar 1972).

Angular distributions were measured for the reactions $^{16}O(^6Li, ^3He)^{19}F$ and $^{16}O(^6Li,t)^{19}Ne$ at a bombarding energy of 24 MeV. A distorted-wave Born-approximation (DWBA) analysis in the zero-range three-nucleon-cluster-transfer approximation was performed. The sensitivity of the DWBA calculations on ^6Li parameters was demonstrated, with 160- to 190-MeV real-well-depth ^6Li parameters giving the best fits. By using Watson's ^6Li parameters it was possible to account for the observed differences between the ($^6Li,^3He$) and (^6Li,t) cross sections. The extracted relative spectroscopic strengths are consistent with the known structure of the final states. (6 figures, 3 tables) (auth)

24235 PIONIC X-RAY YIELDS AND 2p-LEVEL WIDTHS IN ^6Li, ^9Be, ^{12}C, AND ^{16}O. Sapp, W. W. Jr.; Eckhause, M.; Miller, G. H.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., C; 5: No. 3, 690-5(Mar 1972).

The intensities of 2p–1s pionic x-ray transitions in ^6Li, ^9Be, ^{12}C, and ^{16}O were measured using an absolute-efficiency technique. A pion-cascade calculation which was constrained to reproduce the observed yields predicted population probabilities for the mesonic levels and gave values for the strong-interaction level widths. The 2p-level broadenings are 0.015 ± 0.005 eV for ^6Li, 0.16 ± 0.03 eV for ^9Be, 2.1 ± 0.6 eV for ^{12}C, and 12 ± 4 eV for ^{16}O. Comparisons are made with results obtained by others and with predictions based upon a semiphenomenological optical potential. Empirical capture schedules for π^- in ^6Li and ^{12}C are also presented. (3 figures, 2 tables) (auth)

24236 REACTION $^9Be(\alpha,n)^{12}C$ FROM 1.7 TO 6.4 MeV. Obst, A. W.; Grandy, T. B.; Weil, J. L. (Univ. of Kentucky, Lexington). Phys. Rev., C; 5: No. 3, 738-54(Mar 1972).

The 0° excitation functions for the reaction $^9Be(\alpha,n)^{12}C$ leading to the ground and first excited states of ^{12}C were measured between 1.69 and 6.44 MeV bombarding energy, while those for the second- and third-excited-state neutron groups were measured above 2.94 and 5.94 MeV bombarding energy, respectively. Angular distributions of the ground-state and first two excited-state neutron groups were measured at 17 bombarding energies between 3.21 and 6.44 MeV, and for the third-excited-state neutron group they were measured at 6.24 and 6.44 MeV bombarding energy. The magnitude of the cross sections for the ground- and first-excited-state neutron groups agrees well with the larger of the two sets of conflicting magnitudes reported in the literature. Double-differential cross sections of the continuum of low-energy neutrons were measured as a function of angle and neutron energy for 10 bombarding energies ranging from 4.86 to 6.44 MeV. The features of the continuum are consistent with the sequential decay $^9Be + \alpha \rightarrow {}^9Be^* + \alpha' \rightarrow {}^8Be + n + \alpha'$, proceeding through the 1.67-, 2.43-, and 3.04-MeV excited states in ^8Be. The ratio of the populations of the first and second excited states in the $^9Be(\alpha,n)^{12}C$ reaction was determined at 16 bombarding energies between 3.99 and 6.44 MeV. (23 figures, 2 tables) (auth)

24237 MULTIPLE SCATTERING OF PIONS BY ^{12}C. Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 3, 755-61(Mar 1972).

The elastic and inelastic (first excited state only) scattering of pions from ^{12}C is calculated by a method previously described and compared with data from 120 to 280 MeV. It is found that the agreement is comparable with other methods that have been used. An investigation of several possible sources of error in the method is also made. (8 figures) (auth)

24238 ISOSPIN-FORBIDDEN PARTICLE DECAY OF THE FIRST T = $\frac{3}{2}$ STATES IN ^9Be AND ^9B. Adloff, J. C.; Lin, W. K.; Souw, K. H.; Chevallier, P. (Univ. Louis Pasteur, Strasbourg). Phys. Rev., C; 5: No. 3, 664-72(Mar 1972).

The particle decays of the first T = $\frac{3}{2}$ state in $^9Be(^9B)$ were studied by the $^7Li(^3He,pn)$ reaction at E(^3He) = 10.0 MeV (8.7 and 7.95 MeV). Protons (neutrons) emitted at 0° were detected in coincidence with decay neutrons (protons). Neutron energy was determined by the associated-particle time-of-flight technique. The ratios of partial neutron (proton) widths to the ground and first excited states of ^9Be to the ground-state radiative width

Γ_{γ_0} are found to be, respectively, 6.4 ± 2.0 and 20.4 ± 4.6 for the ^{9}Be analog state (<1.5 and 13.9 ± 2.1 for ^{9}B). If Γ_{γ_0} = 10.5 ± 1.5 eV, these results give Γ_{n_0} = 67 ± 26 eV, Γ_{n_1} = 213 ± 56 eV, Γ_{p_0} < 18 eV, and Γ_{p_1} = 147 ± 30 eV for the mirror decays. (8 figures, 3 tables) (auth)

24239 ENERGY OF THE ^{14}N(d,γ_0)^{16}O RESONANCE IN THE GIANT-DIPOLE REGION OF ^{16}O. Weller, H. R. (Univ. of Florida, Gainesville); Blue, R. A.; Blatt, S. L. Phys. Rev., C; 5: No. 3, 648-50(Mar 1972).

The 90° yield from the reaction ^{14}N(d,γ_0)^{16}O was measured between 2.1 and 2.9 MeV to determine accurately the location of the strong resonance previously observed in this region. Two separate measurements were made. It was found that the resonance occurs at E_d = 2.40 ± 0.05 MeV; this value represents a shift with respect to the dip ^{15}N(p,γ_0)^{16}O and ^{16}O(γ,n_0)^{15}O. This result brings into question interpretations of the fine structure of the ^{16}O giant dipole resonance made on the basis of earlier experimental work. (2 figures) (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 24222, 24224, 24232, 24251, 24284, 24369, and 24372.

24240 (CONF-700122–, pp 27-38) (^{3}He,t) REACTION ON S–D SHELL NUCLEI. Schwartz, J. J. (Stanford Univ., Calif.). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

Some recent data on (^{3}He,t) reactions with ^{19}F, ^{26}Mg, ^{27}Al, ^{35}Cl, ^{37}Cl, ^{39}K, and ^{41}K are discussed. The striking similarities in angular distributions for transitions leading to states of the same final J are pointed out. The usefulness of these characteristic angular distributions for postulating spins is illustrated. (J.W.R.)

24241 STUDY OF THE ^{26}Mg(^{6}Li,^{6}He)^{26}Al CHARGE EXCHANGE REACTION. Duhm, H. H. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Ueta, N.; Heinecke, W.; (and others). Phys. Lett.; 38B: No. 5, 306-7(6 Mar 1972).

Angular distributions were measured for the ^{26}Mg(^{6}Li, ^{6}He)^{26}Al reaction at E(^{6}Li) = 36 MeV and analyzed in terms of microscopic DWBA calculations. The angular distributions could be successfully described with a pure $\sigma_0\sigma \cdot \tau_0\tau$ interaction potential. No evidence was found for tensor force contributions. (auth)

24242 STUDY OF STRUCTURE OF GIANT RESONANCE IN ^{32}S USING INELASTIC ELECTRON SCATTERING BY 180°. Belyi, Yu. I.; Kabachnik, N. M. (Moscow State Univ.). Yadern. Fiz.; 14: No. 6, 1113-17(Dec 1971). (In Russian).

The differential cross section of inelastic electron scattering by 180° in ^{32}S with the excitation of giant resonance levels was calculated. All the levels excited by E1 and M2 transitions were taken into account. The calculation was performed in terms of the shell model with the account of the configuration splitting and coupling of the particle-hole excitations with the low-lying one- and two-phonon states. Configuration structure of various parts of the spectrum is analyzed as well as the dependence of the cross section on the electron initial energy (variation of the momentum transfer). The appearance of the magnetic quadrupole resonance at the 16 to 18-MeV excitation energy which becomes a dominant feature of the spectra at high energy of the electron is predicted. A large contribution of transitions from internal 1p shell which determines the behavior of the cross sections at high (30 to 35 MeV) excitation energy was noted. (auth)

24243 HALF-LIVES OF ^{29}Na AND ^{36}K. Moss, C. E. (Univ. of Colorado, Boulder); Detraz, C.; Zaidins, C. S.; Frantsvog, D. J. Phys. Rev., C; 5: No. 3, 1122-3(Mar 1972).

As two conflicting values have been given for the half-lives of both ^{29}Na and ^{36}K, they were carefully remeasured with a "pneumatic-shuttle" system. The results found were $T_{\frac{1}{2}}$ = 446 ± 8 ms for ^{29}Na and $T_{\frac{1}{2}}$ = 343 ± 28 ms for ^{36}K. In addition, and as a check against systematic errors, the half-lives of ^{28}P, ^{32}Cl, ^{40}Sc, and ^{64}Ga were measured. (1 table) (auth)

24244 TRIAXIAL SHAPES FOR sd-SHELL NUCLEI. Kurath, D. (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 3, 768-72(Mar 1972).

The E2 properties and excitation energies of low-lying states in ^{24}Mg, ^{26}Mg, ^{30}Si, and ^{32}S are calculated using the adiabatic model of a triaxially deformed rotor. The results are compared with those of recent shell-model calculations, and strong similarity is found for both ^{24}Mg and ^{32}S with nearly the same deformation parameters in the adiabatic model. The strength for isovector M1 excitation, pertinent to results of inelastic electron scattering, is also calculated using the closure sum rule. (1 figure, 4 tables) (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 24222, 24224, 24232, 24240, 24243, 24268, and 24319.

24245 (CONF-700122–, pp 73-6) LEVELS IN ^{40}Sc VIA THE (^{3}He,t) REACTION ON ^{40}Ca. Schulz, N.; Alford, W. P.; Jamshidi, A. (Rochester Univ., N. Y. Nuclear Structure Research Lab.). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

A high-resolution study of the ^{40}Ca(^{3}He,t) reaction was performed. Triton energy spectra and angular distributions were measured for a ^{3}He energy of 28 MeV. A number of low-lying levels in ^{40}Sc were identified from the results. (J.W.R.)

24246 (CONF-700122–, pp 77-90) STUDY OF THE ^{40}Ca(^{3}He,t)^{40}Sc REACTION AT 30.2 MeV. Loiseaux, J. M.; Kossanyi-Demay, P.; Ha Duc Long; Chaumeaux, A.; Faraggi, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Bruge, G.; Schaeffer, R. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

A silicon E–ΔE detector was used to measure triton spectra and angular distributions from the ^{40}Ca(He-3,t) reaction at an incident energy of 30.2 MeV. The data was used along with the known ^{40}K level scheme to obtain information on the low-lying levels in ^{40}Sc. The reaction was analyzed by microscopic calculations using optical potentials. (J.W.R.)

24247 (CONF-700122–, pp 91-7) ^{48}Ca(^{3}He,t)^{48}Sc REACTION AT 23 MeV. Richter, A.; Comfort, J. R.; Schiffer, J. P. (Argonne National Lab., Ill.). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

Some preliminary results on the structure of some levels in ^{48}Sc studied by the ^{48}Ca(^{3}He,t) reaction at an incident energy of 23 MeV are reported. Angular distributions were analyzed by the DWBA and some tentative angular momentum assignments were made. (J.W.R.)

24248 (NP–19193) SPECTROSCOPY OF ^{55}Cr FROM DIRECT REACTION AND GAMMA RAY STUDIES. Rosalky, David Marcus (Australian National Univ., Canberra). Mar 1971. 178p. Dep. NTIS (U. S. Sales Only).

Thesis.

Spectroscopic information on the states of ^{55}Cr below 3 MeV excitation was derived from two diverse investigations; namely the observation of j-dependence in the reaction ^{54}Cr(d,p)^{55}Cr and, secondly, from the electromagnetic decay scheme as determined by the reaction ^{54}Cr(d,pγ)^{55}Cr. In the first experiment, angular distributions of deuterons scattered from ^{54}Cr, and of protons from the ^{54}Cr(d,p)^{55}Cr reaction were simultaneously measured at 8 MeV and 11 MeV bombarding energies. In an optical model analysis performed on the elastic scattering data, the discrete and continuous parameter ambiguities are studied in terms of the quality of the fits to the angular distributions and the predictions of the reformulated optical model. It is shown that little information can be gained from this analysis about the spin-orbit term in the optical potential. Empirical rules are applied to the observed j-dependence in the l = 1 and l = 3 (d,p) transitions in order to tentatively assign spins to several of the states. In a subsequent DWBA analysis it is shown that an adjustment of the elastic scattering parameters is required in order to fit the backward angle regions of the reaction distributions, and hence the l = 1 j-dependence. The role of the deuteron spin-orbit force is investigated and it is found that an abnormally small geometry, which has been used previously by other authors, is required. Stable absolute values of the spectroscopic factors are obtained by imposing the matter radius relation of the reformulated optical model on the geometry of the bound state potential. By employing the spectroscopic factor sum rules and the results of pickup reactions on ^{54}Cr, a description of the ground state of that nucleus is developed in terms of the configuration of the last two neutrons. The spectrum of ^{55}Cr is then explained in terms of the fragmentation of single particle states coupled to the ^{54}Cr core. The electromagnetic decay scheme of levels up to 2.7 MeV excitation is deduced from the measurement of a proton–gamma ray coincidence spectrum from the reaction ^{54}Cr(d,pγ)^{55}Cr. A line shape analysis is performed on the spectra associated with each state and branching ratios are extracted. A previously unobserved state at 1.135 MeV is proposed and a probable spin-parity assignment of $^7/_2^-$ is made on the

grounds of the decays to and from the state. Consistency between the decay scheme and the results of the (d,p) experiment is discussed, and the level energies, derived from the gamma ray work, are compared with earlier results. (auth)

24249 (ORNL-TM-3442) CALCULATION OF NEUTRON ENERGY-DEPENDENT CAPTURE GAMMA-RAY YIELD SPECTRA FOR IRON AND COMPARISONS WITH EXPERIMENTS. White, J. E.; Fu, C. Y.; Yost, K. J. (Oak Ridge National Lab., Tenn.). 30 Aug 1971. 28p. Dep. NTIS.

The spin-dependent gamma-ray cascade model DUCAL has been applied to calculate neutron energy-dependent capture gamma-ray spectra in iron. There are significant variations in the capture gamma-ray yield spectra with neutron energy. The results have been compared with a series of integral gamma-ray yield measurements above 1 MeV and the agreement found was reasonably good. The yield data are presented in a neutron energy format that would facilitate the preparation of the capture component of the secondary gamma-ray production cross sections in iron. (auth)

24250 (ORNL-TM-3674) LEVEL STRUCTURE OF ^{54}Mn. Dickens, J. K. (Oak Ridge National Lab., Tenn.). 14 Jan 1972. 21p. Dep. NTIS.

Properties of levels in ^{54}Mn have been studied using the ^{54}Fe (p,nγ)^{54}Mn reaction. These data alone were not sufficient to determine spin and parity assignments, but when correlated with data from prior experimental investigations of the ^{54}Mn nucleus, a set of unique J^{π} assignments for the lowest five excited states was determined. These assignments are consistent with nearly all presently available experimental data and are in good agreement with shell-model calculations. The level excitation energies and J^{π} values obtained are: ground-state, 3^+, 54.3 keV, 2^+; 156.9 keV, 4^+; 367.6 keV, 5^+; 407.5 keV, 3^+; and 839.0 keV, 4^+. Transitions from higher lying states were observed and possible J^{π} values were obtained. (auth)

24251 ELASTIC AND INELASTIC SCATTERING OF 12 TO 17-MeV ALPHA PARTICLES ON A = 20 TO 68 TARGETS. Ivascu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: No. 5, 477-519(1970). (In Rumanian).

After a general introduction, the theories used to analyze alpha scattering are explained. Modern theories for elastic scattering include the "black nucleus" model of Blair, the Akhiezer–Pomeranchuk–Blair–McIntyre model with resonances, and the optical model; theories for inelastic scattering include the DWBA, coupled-channels theory, the model of Blair, Sharp, and Wilets, and the Austern–Blair model. Angular correlations are also considered. The experimental arrangement and procedures, such as the cyclotron and beam optics, the scattering equipment, the detectors and electronics, the targets, and the calculation of differential cross sections, are described. Angular distributions in the energy range between 12 and 17 MeV are presented for elastic and inelastic scattering of α by ^{20}Ne, ^{40}Ar, ^{54}Fe, ^{58,60}Ni, and ^{66,68}Zn. Data are also presented for inelastic scattering by ^{32}S at 12 to 16 MeV. Alpha scattering by ^{24}Mg and ^{48}Ti was investigated as well. (25 figures, 1 table, 37 references. (R.W.R.)

24252 EXCITATION OF COLLECTIVE STATES OF SOME MEDIUM NUCLEI BY 14-MeV NEUTRONS. Leshchenko, B. E.; Gurtovoi, M. E.; Kukhlenko, A. S.; Strizhak, V. I. (Kiev State Univ.). Yadern. Fiz.; 15: No. 1, 10-17(Jan 1972). (In Russian).

The differential cross sections for elastic and inelastic scattering of 14 MeV neutrons on low-lying collective states were measured for Ti, Fe, Y, Zr. The inelastically scattered neutrons were separated from those elastically scattered by the time of flight system with the energy resolution of 450 keV for 14 MeV neutrons. The cross sections obtained for excitation of collective quadrupole and octupole states are compared to the coupled channels theory. The nuclear deformation parameters are extracted, and these are compared to the values obtained from other direct interaction experiments. (auth)

24253 γ-EMISSION IN RADIATIVE CAPTURE OF INTERMEDIATE NEUTRONS. Gamalii, A. F.; Zemtsev, B. V.; Ivanov, V. B.; Nesterov, B. V.; Kham'vanov, L. P. Yadern. Fiz.; 15: No. 1, 3-9 (Jan 1972). (In Russian).

The spectra of the capture γ-emission on ^{95,97}Mo, ^{62}Ni, ^{48}Ti nuclei in radiative capture of thermal neutrons and of neutrons with energies 2 and 25 keV were studied using γ-spectrometer with Ge–Li detector. The neutrons with the averaged energies 2 and 25 keV were selected from the solid spectrum of reactor with the help of scandium and ferroaluminium filters. (auth)

24254 HARTREE-FOCK CALCULATIONS WITH SKYRME'S INTERACTION. I. SPHERICAL NUCLEI. Vautherin, D. (Massachusetts Inst. of Tech., Cambridge. Institut de Physique Nucleaire, Orsay, France); Brink, D. M. Phys. Rev., C; 5: No. 3, 626-47(Mar 1972).

Hartree–Fock calculations for spherical nuclei using Skyrme's density-dependent effective nucleon–nucleon interaction are discussed systematically. Skyrme's interaction is described; and the general formula for the mean energy of a spherical nucleus derived. Hartree–Fock equations are obtained by varying the mean energy with respect to the single-particle wave functions of occupied states. Relations between the parameters of the Skyrme force and various general properties of nuclear matter and finite nuclei are analyzed. Calculations were made for closed-shell nuclei by using two rather different sets of parameters, both of which give good binding energies and radii for ^{16}O and ^{208}Pb. Both interactions give good binding energies and charge radii for all closed-shell nuclei. Calculated electron scattering angular distributions agree qualitatively with experiment, and for one interaction there is good quantitative agreement. The single-particle energies calculated with the two interactions are somewhat different owing to a different nonlocality of the Hartree–Fock potentials, but both interactions give the correct order and density of single-particle levels near the Fermi level. They differ most strongly in their predictions for the energies of 1s single-particle states. (12 figures, 4 tables) (auth)

24255 EFFECTS OF TWO-STEP PROCESSES ON THE ^{40}Ca (t,d) AND (d,p)^{41}Ca($\frac{3}{2}^+$,2.02 MeV) REACTIONS. Tamura, T.; Udagawa, T. (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 3, 1127-30(Mar 1972).

An investigation is made of the effects of two-step processes on both the (t,d) and (d,p) reactions on ^{40}Ca, leading to the $\frac{3}{2}^+$ 2.02-MeV state in ^{41}Ca. The particular process considered is that in which the 3^- collective state in ^{40}Ca is excited first and then the stripping follows. The effects were found weak for both the (t,d) and d,p) reactions. (3 figures) (auth)

24256 ENERGY DEPENDENCE IN (^{3}He,t) TRANSITIONS TO ISOBARIC ANALOG GROUND STATES. Fadner, W. L. (Univ. of Colorado, Boulder); Kraushaar, J. J.; Hayakawa, S. I. Phys. Rev., C; 5: No. 3, 859-63(Mar 1972).

Transitions to the isobaric analog ground states of ^{50}Cr, ^{54}Fe, ^{62}Ni, and ^{90}Zr were studied with the (^{3}He,t) reaction in the energy range of 21.4 to 37.5 MeV. Large variations in the shape of the experimental angular distributions were observed as a function of energy and target nucleus. These effects were poorly described by distorted-wave Born-approximation calculations based on a simplified shell-model theory. Calculations based on a generalized optical model, using different interaction terms for each nucleus, gave a somewhat better description. Interaction strengths, normalized to fit the data, required a significant decrease with increasing energy for both theoretical models. These effects were general, to a large extent independent of the optical-model parameter set used. The poor description, both in shape and in strength, of the energy dependence of the data is evidence of basic inadequacies in the theories as they are presently used. (3 figures, 1 table) (auth)

24257 SUBSTATE EXCITATION OF 2^+ STATES PRODUCED BY INELASTIC SCATTERING OF PROTONS ON ^{12}C, ^{54}Fe, AND ^{58}Ni. Tesmer, J. R.; Schmidt, F. H. (Univ. of Washington, Seattle). Phys. Rev., C; 5: No. 3, 864-75(Mar 1972).

A combined analysis of absolute in-plane and z-axis (spin-flip) p–γ angular correlation measurements for $0^+-2^+-0^+$ transitions leads to various combinations of substate cross sections, populations, and phase angles. These quantities are compared with predictions based on reaction-mechanism theories. The test is very stringent. Measurements and analyses were carried out for ^{12}C(p,p′γ)^{12}C*(4.44 MeV) and ^{58}Ni(p,p′γ)^{58}Ni*(1.45 MeV) at E_p = 20 MeV and for ^{54}Fe(p,pγ)^{54}Fe*(1.41 MeV) at E_p = 19.6 MeV. Each of the three nuclei studied exhibits the following qualitative features: The total inelastic cross sections have a less pronounced structure than do the individual substate cross sections. The M = 0 cross section is the most diffractionlike; the oscillations are out of phase with respect to the oscillations of the elastic cross section. The sum of the M = +2 and M = 2 cross sections also are diffractionlike, but are not in phase with the M = 0. Detailed comparisons with collective-model distorted-wave Born-approximation predictions are, on the whole, quite good for ^{58}Ni and ^{54}Fe, especially when the full Thomas form for the spin-dependent perturbation potential is used. The isotropic term in the in-plane angular-correlation function is particularly sensitive to the form and strength of the spin–orbit coupling potential. For ^{54}Fe the predictions are further improved when the strength of the spin-dependent perturbation potential is increased by setting the spin-dependent deformation equal to twice the central-potential deformation. (9 figures, 1 table) (auth)

24258 (^{3}He,n) REACTION TO THE CONTINUUM NEAR A = 50. Grimes, S. M.; Anderson, J. D.; McClure, J. W.; Pohl, B. A.;

Wong, C. (Univ. of California, Livermore). Phys. Rev., C; 5: No. 3, 830-7(Mar 1972).

Neutron spectra produced by the (^{3}He,n) reaction on targets of ^{45}Sc, ^{48}Ti, ^{49}Ti, ^{51}V, ^{52}Cr, ^{56}Fe, ^{58}Fe, ^{59}Co, and ^{60}Ni were obtained for bombarding energies of 10.5 and 15 MeV. Peaks were observed in the forward-angle spectra, but they disappeared for angles larger than 30°; only a structureless continuum was left. Examination of the energy dependence in the region corresponding to residual excitations of between 3 and 8 MeV shows better agreement with the calculation assuming a knockout reaction mechanism than that assuming a stripping reaction, although the peaks seen in the forward-angle spectra correspond to stripping reactions. The Griffin formula for calculating densities of particle–hole states is compared with values obtained from combinations of a specific single-particle level scheme; good agreement is found. (3 figures, 3 tables) (auth)

24259 LEVEL STRUCTURE OF ^{44}Ca WITH THE HAMADA–JOHNSTON AND TABAKIN INTERACTIONS. Fu, C. C.; Singh, R. P.; Raj, R.; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 5: No. 3, 1137-9(Mar 1972).

A comparative study of the level structure of ^{44}Ca is made employing the conventional shell-model and Kuo–Brown matrix elements for the Hamada–Johnston interaction and Clement matrix elements for the Tabakin interaction. Results on spectroscopic strengths for the reaction ^{43}Ca(d,p)^{44}Ca and transition rates are also reported. Except for some differences, the two interactions are found to give essentially similar results. Some differences with the earlier calculation of McGrory, Wildenthal, and Halbert are also pointed out. (1 figure, 2 tables) (auth)

24260 ELECTROMAGNETIC TRANSITIONS IN ^{51}V AND ^{53}Mn. Goodman, A. S.; Donahue, D. J. (Univ. of Arizona, Tucson). Phys. Rev., C; 5: No. 3, 875-89(Mar 1972).

Attenuated Doppler shifts and particle–γ-ray angular correlations were measured and interpreted to yield properties of electromagnetic transitions in ^{51}V and ^{53}Mn. Mean lives were obtained for states at 1.609, 1.813, 2.402, 2.670, and 2.699 MeV in ^{51}V and for states at 1.288, 1.440, 1.619, 2.277, 2.406, 2.575, 2.641, and 2.705 MeV in ^{53}Mn. Possible multipole mixing ratios were deduced for the transitions (energies in MeV) 0.378 → 0, 1.288 → 0.378, 1.619 → 0, 2.277 → 0, and 2.406 → 1.288 in ^{53}Mn. A possible identification of a $15/2^-$ state in ^{53}Mn is presented. From these results and the results of other workers, transition probabilities in ^{51}V and ^{53}Mn were calculated and compared with one another, with a $(1f_{7/2})^n$ pure-configuration shell-model calculation, and with a mixed-configuration calculation. (13 figures, 10 tables). (auth)

24261 NUCLEAR-ORIENTATION AND ANGULAR-CORRELATION STUDIES OF ^{57}Fe AND ^{58}Fe. Fox, R. A.; Hamilton, W. D.; Holmes, M. J. (Univ. of Sussex, Brighton, Eng.). Phys. Rev., C; 5: No. 3, 853-8(Mar 1972).

The E2:M1 multipole mixing ratio of the $5/2^- \rightarrow 3/2^-$ and $2^+ \rightarrow 2^+$ transitions between the second and first excited states in ^{57}Fe and ^{58}Fe, respectively, were measured. The nuclear-orientation sources were prepared by diffusing cobalt activity into iron. Nuclear polarization was obtained by cooling the sample to 25 mK by using a ^{3}He–^{4}He dilution refrigerator and applying sufficient external magnetic field to saturate the iron. The value $\delta = 0.120 \pm 0.002$ was obtained for the 122-keV transition in ^{57}Fe by a nuclear-orientation measurement. The ^{58}Fe γγ angular-correlation results used (a) NaI(Tl)–NaI(Tl) and (b) Ge(Li)–NaI(Tl) detector combinations and gave consistent results: (a) $A_{22} = 0.460 \pm 0.013$, $A_{44} = 0.150 \pm 0.021$; (b) $A_{22} = 0.45 \pm 0.04$, $A_{44} = 0.08 \pm 0.09$. The orientation experiment yielded $A_2 = 0.33 \pm 0.03$. These values give $\delta = 0.69 \pm 0.05$ for the 865-keV transition. From a knowledge of the temperature of the orientated nuclei the Fermi to Gamow–Teller matrix-element ratio, λ, of the two $2^+ - 2^+$ electron-capture and β^+ transition from ^{58}Co were obtained. For the transition to the 1675-keV level $\lambda = 0.07 \pm 0.06$ and to the 810-keV level $\lambda = 0.04 \pm 0.06$. The mixing ratio measurements remove existing possible ambiguities and illustrate the very useful advantages of combining nuclear-orientation and angular-correlation methods. (5 figures, 2 tables) (auth)

24262 STUDY OF THE REACTION ^{48}Ca(^{3}He,t)^{48}Sc AT 23 MeV AND THE STRUCTURE OF ^{48}Sc. Richter, A. (Argonne National Lab., Ill.); Comfort, J. R.; Anantaraman, N.; Schiffer, J. P. Phys. Rev., C; 5: No. 3, 821-9(Mar 1972).

The level structure of ^{48}Sc was investigated in the reaction ^{48}Ca(^{3}He,t)^{48}Sc at E(^{3}He) = 23 MeV. Angular distributions for the $(\nu f_{7/2}^{-1}\pi f_{7/2})$ states were measured from 10 to 90° in 5° steps and from 100 to 140° in 10° steps with a split-pole spectrograph and compared with microscopic distorted-wave calculations (including a tensor force for the transitions into states having odd angular momentum J). In addition, a number of strongly excited states were seen at and above 3 MeV excitation energy, and angular distributions for these were taken from 10 to 50° in 5° steps. Comparison with distorted-wave calculations suggests several candidates for states belonging to odd-parity multiplets, which would be expected in this region of excitation from the configurations $(s_{1/2}^{-1}f_{7/2})$ and $(d_{3/2}^{-1}f_{7/2})$. Possible candidates for the expected even-parity states belonging to $(f_{7/2}^{-1}p_{3/2})$ and $(f_{7/2}^{-1}f_{5/2})$ are also tentatively identified. (5 figures, 5 tables) (auth)

24263 EXPERIMENTAL 0_2^+(2.12 MeV) → 2_1^+(1.46 MeV) B(E2) STRENGTH AND PAIRING–VIBRATION CALCULATIONS IN ^{40}Ar. Henson, S. H.; Cochavi, S.; Fossan, D. B.; Vergados, J. D. (State Univ. of New York, Stony Brook). Phys. Rev., C; 5: No. 3, 791-9(Mar 1972).

The lifetime of the 2.12-MeV 0_2^+ state in ^{40}Ar was measured by a p–γ delayed-coincidence technique. This state was populated by the (p,p′) reaction with 5.3-MeV protons bombarding an Ar gas target. A mean lifetime of $\tau = 150 \pm 20$ ps was obtained for the 0_2^+ state. This lifetime implies for the $0_2^+ \rightarrow 2_1^+$ transition $B(E2) = 42.9 \pm 5.7\ e^2\ F^4$. Pairing–vibration model calculations for ^{40}Ar were made using experimental information regarding energies and B(E2) strengths for the three lowest levels of both ^{42}Ca and ^{38}Ar. Three kinds of interaction were considered: first, no interaction; second, a phenomenological quadrupole–quadrupole interaction; and third, the Kuo–Brown bare G matrix elements. None of these calculations can accurately describe both the energy spectrum and the E2 transition strengths in ^{40}Ar. This result may be an indication of the inadequacy of the pairing–vibration model for ^{40}Ar. (7 figures, 5 tables) (auth)

24264 STUDY OF ^{48}Sc BY THE REACTION ^{46}Ca(α,d)^{48}Sc. Richter, A. (Argonne National Lab., Ill.); Comfort, J. R.; Yntema, J. L.; Anantaraman, N.; Schiffer, J. P. Phys. Rev., C; 5: No. 3, 814-20(Mar 1972).

Angular distributions in the range 10 to 60° were measured for the reaction ^{46}Ca(α,d)^{48}Sc at $E_\alpha = 25$ MeV. The lowest final states populated are those of odd angular momentum $J^\pi = 1^+, 3^+, 5^+$, and 7^+ belonging to the configuration $(\nu f_{7/2}^{-1}\pi f_{7/2})$. As expected, the even-J states $J^\pi = 2^+, 4^+$, and 6^+ of this configuration are only very weakly excited. Angular distributions for several additional states up to 4.2 MeV excitation in ^{48}Sc were also measured. The cross sections for these higher states are an order of magnitude lower than would be estimated from normalizing the microscopic distorted-wave calculations to the low-lying states. (7 figures, 3 tables) (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 22877, 24222, 24224, 24243, 24251–24253, 24256, 24258, 24275, 24284, 24288, 24293, 24319, and 24326.

24265 (FRNC-TH-136) SEARCH FOR MEDIUM AND HEAVY NUCLEI WITH SHAPE INSTABILITIES. Macias-Marques, Maria Ines (Paris Univ., Orsay (France)). 1971. 82p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A new region of medium and heavy deformed nuclei was sought. Neutron rich Rb and Sr, and ^{190}Pt and ^{227}Ac nuclei were studied. Instrumentation was developed for determining the energies and intensities of the β radiation and the internal conversion electrons. The production and separation of the transition nuclei $^{89-96}$Rb → $^{89-96}$Sr, $^{93-95}$Sr → $^{93-95}$Y were studied, and the mean energy of the β spectra, and the Q(β) value were determined. The ^{90}Sr level scheme and the γ spectra of $^{92-96}$Rb and ^{95}Sr are given. Some ^{190}Pt transitions were studied. The internal conversion electron spectrum of the 8.4-keV transition involved in the ^{169}Er → ^{169}Tm transition is given. The half lives of the ^{227}Ac nuclei were measured. It is shown that Sr isotopes and ^{190}Pt do not present stable deformations; in contrast ^{227}Ac appears to undergo stable deformation up to energy states less than 500 keV. (France)

24266 NUCLEAR-STRUCTURE INVESTIGATIONS IN SPHERICAL HEAVY NUCLEI BY MEANS OF INELASTIC ELECTRON SCATTERING. Theis, Werner (Technishce Univ., Hanover). Z. Phys.; 250: No. 2, 99-119(1972).

Inelastic electron scattering form factors for the low-lying 2^+ and 3^- excitations in ^{88}Sr and the first 3^- excitation in ^{208}Pb are calculated on the basis of a microscopic nuclear model making use of various residual two-particle interactions. The aim is to draw conclusions from the comparison of the theoretical and experimental data upon the nuclear model itself and upon the employed residual interactions. Further experimental data especially for high momentum transfers will be needed for the excitations in ^{88}Sr. The existing data for ^{208}Pb show that the used effective interactions are not yet satisfactory. (auth)

24267 POTENTIAL MODEL INTERPRETATION OF ISOBARIC ANALOG RESONANCES APPLICABLE TO EVEN–EVEN AND EVEN–ODD TARGETS. Spencer, J. E.; Kerman, A. K. (Univ. of California, Livermore). Phys. Lett.; 38B: No. 5, 289–92(6 Mar 1972).

With a reasonably general expression for the effective nucleon–nucleus interaction, it is shown that a single set of potential parameters can reproduce both the resonance energies and the spectroscopic factors observed for a range of nuclei. The range and variety of experimental data considered makes possible a consistent and sensitive determination of the real central potential, the isospin, and the spin–spin dependent potential terms in the effective interaction. (auth)

24268 PROTON ELASTIC SCATTERING MEASUREMENTS AT 16 MeV WITH OPTICAL-MODEL ANALYSIS. Makofske, W.; Greenlees, G. W.; Liers, H. S.; Pyle, G. J. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 5: No. 3, 780–91(Mar 1972).

Differential cross-section measurements are presented for the elastic scattering of 16-MeV protons from ^{58}Ni, ^{60}Ni, ^{62}Ni, ^{64}Ni, ^{90}Zr, ^{120}Sn, and ^{208}Pb. In general, the angular range 15 to 160° was covered with a relative uncertainty in the cross sections of ±1%. The data are analyzed using an optical model in three ways: by fitting individual data sets for each element with a nine-parameter model; by fitting all the data simultaneously with a "global" search routine; and by fitting individual data sets with the "folding" version of the model, due to Greenlees, Pyle, and Tang. The lack of constraints on the spin–orbit parameters due to the absence of polarization data is overcome to some extent by the second procedure. The ambiguities associated with the spin–orbit term are investigated in some detail. The results confirm trends with mass number found at higher energies, and suggest that effects not included in the usual forms of the model are present in the interaction. (3 figures, 7 tables) (auth)

24269 TWO-HOLE AND TWO-PARTICLE-FOUR-HOLE STATES IN ^{88}Sr AND THE DECAY OF 17.8-MIN ^{88}Rb. Ragaini, R. C. (Los Alamos Scientific Lab., N. Mex. Washington State Univ., Pullman); Meyer, R. A. Phys. Rev., C; 5: No. 3, 890–8 (Mar 1972).

The population of levels of ^{88}Sr from the decay of 17.8-min ^{88}Rb was investigated by studying the ^{88}Rb γ rays with a Ge(Li) Compton-suppression spectrometer and with large-volume Ge(Li) detectors. Forty-two γ rays are identified as originating from ^{88}Rb, and 31 of them are assigned to 18 levels of ^{88}Sr. Discrepancies which existed among previous Ge(Li) γ-ray studies are resolved. The levels populated from ^{88}Rb decay are compared with the levels of ^{88}Sr populated by other reactions. The nature of the levels is discussed in terms of two-hole and two-particle–four-hole excitations and collective modes of excitations. (4 figures, 5 tables). (auth)

24270 EXPERIMENTAL STUDY OF THE STRUCTURE OF ^{90}Y WITH ^{89}Y(d,p) AT 33.3 MeV AND ^{89}Y(α,^{3}He) AT 65.7 MeV. Goans, R. E. (Univ. of Tennessee, Knoxville); Bingham, C. R. Phys. Rev., C; 5: No. 3, 914–21(Mar 1972).

Differential cross sections from 12.5 to 47.5° were measured for the ^{89}Y(d,p) reaction with 33.3-MeV deuterons. Proton spectra up to 5 MeV excitation in ^{90}Y were observed with a resolution of approximately 25 keV. The excitation energies agreed within experimental error with (d,p) experiments at 12 and 15 MeV. The ^{89}Y(α,^{3}He) cross sections were measured at 15 and 20° with 65.7-MeV α particles. Comparisons were made with distorted-wave Born-approximation calculations, and l transfers were assigned to many levels. The l transfers and spectroscopic factors are in satisfactory agreement with previous papers for strong transitions populated by low-l transfers. The 33.3-MeV deuteron bombarding energy produced angular distributions permitting analysis of several states not previously interpreted or previously misinterpreted. A comparison of (d,p) and (α,^{3}He) results provides new information on l = 5 transitions. The transitions to states at 1.962 and 2.245 MeV, previously assigned as either l = 4 or l = 4 and 5, are given l = 5 assignments. New l = 5 transitions were observed to levels at 2.088, 2.517, 3.516, and 4.069 MeV, and probable l = 5 transitions were observed to levels near 2.753, 3.004, 3.160, and 3.634 MeV. (8 figures, 2 tables). (auth)

24271 DECAY OF ^{84}Br. Hill, John C. (Texas A and M Univ., College Station); Wang, K. H. Phys. Rev., C; 5: No. 3, 805–13(Mar 1972).

The decay of ^{84}Br to levels in ^{84}Kr was investigated using Ge (Li) and NaI(Tl) γ detectors. On the basis of energy, intensity, and coincidence measurements a new decay scheme including 20 levels is proposed. Out of a total of 51 γ rays observed, all but 3 were placed in the level scheme. The level scheme includes states at 1837, 2489, 3870, 3879, and 4189 keV not seen in previous decay studies. Spin assignments were made for most levels based on the γ-intensity measurements and log-ft values. The level scheme is compared with the results of recent (α,2nγ) and (p,t) reaction studies. (8 figures, 1 table) (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 24224, 24252, 24254, 24256, 24265, 24267 – 24268, 24270, 24275, 24279, and 24319.

24272 (AE–443) FAST NEUTRON RADIATIVE CAPTURE CROSS SECTIONS FOR SOME IMPORTANT STANDARDS FROM 30 keV TO 1.5 MeV. Hellstroem, J. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Dec 1971. 23p. Dep. NTIS (U. S. Sales Only).

Neutron capture radiative cross sections for Ta, Ag, In and Au have been measured between 30 keV and 1.5 MeV using time-of-flight technique. The detector used was a large liquid scintillator. Cross sections are given in relative and absolute units. (auth) (Sweden)

24273 (BNL-tr–463) NEUTRON-SPECTROSCOPIC INVESTIGATION OF SEPARATED SILVER ISOTOPES. Muradyan, G. V.; Adamchuk, Yu. V. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from pp 79-91 of STI/PUB–140(Vol.1). 23p. (CONF-661014–52). Dep. NTIS.

Measurements of the radiative capture in silver-107 and -109 up to 1 keV were performed using the time-of-flight method with the neutron spectrometer. The level spacings and other parameters for these isotopes are given. The results indicate that the small level spacing for silver occurred less frequently than that for the Wigner distribution when several level systems overlapped. (J.F.P.)

24274 (CONF-700122) ARGONNE (^{3}He,t) SYMPOSIUM, CHICAGO, ILLINOIS, JANUARY 25, 1970. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 97p. Dep. NTIS.

Separate abstracts were prepared for the seven papers included. (J.W.R.)

For abstracts of individual papers see: 24240, 24245–24247, 24275, and 24339–24340.

24275 (CONF-700122–, pp 55-71) (^{3}He,t) REACTION IN THE A ≈ 90 REGION. Schiffer, J. P. (Argonne National Lab., Ill.). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

Some experiments on (^{3}He,t) reactions in the A ≈ 90 region are described. Features of these experiments which bear on the reaction mechanism as well as nuclear structure properties are pointed out. Some preliminary results from (^{3}He,t) reactions on ^{90}Zr, ^{88}Sr, and ^{96}Zr are presented. Spin assignments for levels in ^{89}Y, ^{99}Nb, and ^{96}Nb are discussed. (J.W.R.)

24276 (COO–7-620) MAGNETIC MOMENT MEASUREMENTS OF FIRST (2^+) AND SECOND (4^+) STATES OF EVEN Nd AND Sm NUCLEI. Kugel, H. W.; Borchers, R. R. (Wisconsin Univ., Madison); Kalish, Rafael (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science. Technion-Israel Inst. of Tech., Haifa. Wisconsin Univ., Madison). [1971]. Contract AT(11-1)-GEN-7. 33p. Dep. NTIS.

The ion implantation perturbed angular correlation technique was used to measure γ-ray angular distributions from the decay of the first (2^+) and second (4^+) states of even Nd and Sm nuclei recoiled into polarized iron. These data and the results of previous measurements give values of $H_0 = 2.4 \pm 0.3$ MOe for H (NdFe), $H_0 = 2.3 \pm 0.2$ MOe for H(SmFe) and $H_0\tau_1 = 10.8 \pm 8.9$ MOe-ps for the transient effect for Sm and Nd nuclei recoil implanted into polarized iron (300°K). The g-factor results for the first (2^+) states of ^{144,146,148}Nd and ^{148,150}Sm and for the second (4^+) states of ^{150}Nd and ^{152,154}Sm show a rather strong decreasing trend with decreasing neutron number. (auth)

24277 (COO–1779-52) CONFIRMATION OF THE SYSTEMATIC POPULATION OF THREE-QUASIPARTICLE MULTIPLETS BY NUCLIDES BELOW N = 82: A MULTIPLET IN ^{141}Pm. McHarris, Wm. C.; Eppley, R. E.; Warner, R. A.; Todd, R. R.; Kelly, W. H. (Michigan State Univ., East Lansing. Cyclotron Lab.). [1971]. 10p. (MSUCL–31). Dep. NTIS.

The ϵ decay of ^{141m}Sm preferentially populates a multiplet of six (possibly seven) $^9/_2^-$ and/or $^{11}/_2^-$ states lying between 1414.8 and 2702.4 keV in ^{141}Pm. In simple shell-model terms this decay can be represented as $(\pi d_{\frac{5}{2}})^2(\nu d_{\frac{5}{2}})^{-2}(\nu h_{\frac{11}{2}})^{-1} \rightarrow (\pi d_{\frac{5}{2}})(\nu d_{\frac{5}{2}})^{-1}(\nu h_{\frac{11}{2}})^{-1}$, confirming the systematic population of three-quasiparticle multiplets by certain N = 79 and N = 77 nuclides. (auth)

24278 (COO-1779-53) DECAY OF ^{141m}Sm: A THREE-QUASIPARTICLE MULTIPLET IN ^{141}Pm. Eppley, R. E.; Todd, R. R.; Warner, R. A.; McHarris, Wm. C.; Kelly, W. H. (Michigan State Univ., East Lansing. Cyclotron Lab.). [1971]. 62p. (MSUCL-33). Dep. NTIS.

The γ rays emitted following the decay of 22.1-min ^{141m}Sm with Ge(Li) and NaI(Tl) detectors in various singles, coincidence, and anticoincidence configurations, including Ge(Li)-Ge(Li) two-dimensional "megachannel" coincidence experiments are studied. Of the 47 γ rays definitely established as belonging to ^{141m}Sm decay, all but six very weak ones were placed in a consistent decay scheme. The energies [and J^π assignments] of the states in ^{141}Pm populated by the decay of ^{141m}Sm are 0 [$5/2^+$], 196.6 [$7/2^+$], 628.6 [$11/2^-$], 804.5 [$11/2^+$, $9/2^+$], (837.1) [$9/2^+$], 974.0 [$9/2^+$], 1108.1 [$7/2^+$, $9/2^+$, ($5/2^-$)], 1167.2 [$13/2^-(+)$, $11/2^-(+)$, $9/2^-(+)$], 1313.2 [$13/2^-(+)$, $11/2^-(+)$, $9/2^-(+)$], 1414.8 [$11/2^-$, $9/2^-$], (1834.0) [$11/2^-$, $9/2^-$], 1983.1 [$5/2^-$], 2063.5 [$11/2^-$, $9/2^-$], 2091.6 [$11/2^-$, $9/2^-$], 2119.0 [$11/2^-$, $9/2^-$], and 2702.4 keV [$13/2^-$, $11/2^-$, $9/2^-$]. Less than 0.2% of the decay of $11/2^-$ ^{141m}Sm proceeds via an M4 isomeric transition to 11.3-min $3/2^+$ ^{141g}Sm. Two thirds of the ^{141m}Sm ϵ decay goes to the six (possible seven) highest-lying states in ^{141}Pm, another example analogous to ^{139m}Nd decay of the population of a well-defined three-quasiparticle multiplet by an N = 79 nuclide. In simple shell-model terms this can be written as $(\pi d_{5/2})^2(\nu d_{5/2})^{-2}(\nu h_{11/2})^{-1} \rightarrow (\pi d_{5/2})^1(\nu d_{5/2})^{-1}(\nu h_{11/2})^{-1}$. Most of the remaining states can be characterized quite satisfactorily as specific single-particle and core-coupled states. The behavior of these states allows one to add considerably to the systematics of shell-model orbits and their occupations in this region below N = 82. (auth)

24279 (COO-1779-56) (p,t) REACTION ON RARE EARTH NUCLEI. Goles, Ronald William (Michigan State Univ., East Lansing. Dept. of Chemistry). 1971. 146p. Dep. NTIS.

Thesis.

The (p,t) reaction on ^{141}Pr, ^{159}Tb, ^{165}Ho and ^{169}Tm was carried out for the purpose of studying the general systematics of the (p,t) reaction on rare earth nuclei. All experiments were conducted at the bombarding energy of 30 MeV with the exception of the ^{141}Pr(p,t) experiment which was carried out at 40 MeV. The (p,t) reaction on ^{141}Pr was found to strongly populate collective vibrational states in the more or less spherical ^{139}Pr nucleus. Angular distributions of states populated through this reaction were collected between 15 and 65 at 5° intervals and were compared with distorted wave calculations. In each of the remaining deformed nuclei studied, a strong population of the ground state rotational band was observed with at least six band members being excited in each case. Moreover, a β vibrational band in ^{157}Tb and γ vibrational bands in ^{157}Tb and ^{163}Ho were also found to be strongly excited through this reaction. Angular distributions of states below 1.25 MeV of excitation populated through the ^{159}Tb(p,t) reaction were taken between 10 and 75 at 5° intervals and were compared with distorted wave predictions. In addition, γ ray experiments involving the ϵ/β^+ decay of ^{167}Yb were conducted in order to complement the ^{169}Tm(p,t) experiment. This decay scheme study has established the existence of twelve new excited states and the probable placement of a thirteenth in the daughter nucleus ^{167}Tm. Moreover, these thirteen states together with the well established low-energy level structure of the ^{167}Tm nucleus form a consistent framework for the placement of 52 new γ rays associated with the decay of ^{167}Yb. (auth)

24280 (FRNC-TH-126) DETERMINATION OF THE RADII OF NEUTRONS USING THE ELASTIC SCATTERING OF 166-MeV ALPHA PARTICLES. Le Bornec, Yves (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 57p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A method for determining neutron radii using the elastic scattering of 166-MeV alpha particles by different nuclei is described. It is based on the construction of a microscopic optical potential from an effective alpha nucleon interaction and from the distribution of matter in the target nucleus. This potential is fitted to the experimental results by varying a single distribution parameter. Since the charge distribution is known, the neutron distribution and the neutron radius can be obtained. The results were compared with those obtained by other methods. (France)

24281 (NP-19155) ANNUAL REPORT, APRIL 1970-MARCH 1971. (Tokyo Univ. (Japan). Inst. for Nuclear Study). 156p. Dep. NTIS (U. S. Sales Only).

Research and development by the low-energy physics division, the high-energy physics division, the study group for the proton synchrotron, the cosmic ray physics division, and the theoretical physics division of the Institute for Nuclear Study at the University of Tokyo from April 1970 through March 1971 is described. The support activities of the chemistry laboratory and general services sections are also described. (J.W.R.)

24282 (ORNL-tr-2553) PRODUCTION OF NEW ISOMERIC STATES THROUGH PHOTONUCLEAR REACTIONS IN ANTIMONY AND IN THALLIUM. Engelmann, R.; Hepp, V.; Kluge, E.; Krehbiel, H.; Meyer-Berkhout, U. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Phys.; 168: 544-52 (1962). 13p. Dep. NTIS.

The systematic search for new short-lived isomeric states was continued by irradiation of an additional 32 selected elements with 26-MeV bremsstrahlung. Isomeric transitions were detected using a conventional scintillation spectrometer. Irradiation of antimony led to the production of a new (530 ± 50) μsec isomeric state which decays through emission of partially converted (62 ± 2)- and (76 ± 3)-keV gamma rays. The 530 μsec half-life is tentatively associated with the 136-keV level in ^{122}Sb. An apparent inconsistency in the previously proposed level scheme of ^{122}Sb can be removed if the 3.5 min ^{122}Sb-activity is assigned to an isomeric level in ^{122}Sb lying less than 15 keV above the 136 keV isomeric state. A new measurement of the half-life of this level yielded a value of (4.1_5 ± 0.2) min. Another new isomeric state with a (2.1 ± 0.2) msec half life was produced by irradiating thallium. The isomeric state decays by emission of two gamma rays of (335 ± 8) keV and (597 ± 12) keV which were found to be in coincidence. Irradiation of erbium led to the production of a short-lived isomeric transition which may be identical with a previously reported Ho-isomer. Results are discussed. (auth)

24283 GAMMA-RAY SPECTRUM OF ^{145}Ce. Ohyoshi, Emiko (Kumamoto Univ., Japan); Ohyoshi, Akira; Tamai, Tadaharu; Shinagawa, Mutsuaki. J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 125-7(Feb 1972).

The γ-ray spectrum for the decay of ^{145}Ce was studied with a Ge(Li) detector. Cerium isotopes were separated from the fission products produced by neutron irradiation of a uranyl nitrate solution using electromigration with NTA. The γ-ray spectrum was taken 6.5 min. after termination of irradiation. The ^{145}Ce γ rays were identified by half-life. The observed γ rays were fitted into a decay scheme. (J.W.R.)

24284 ANGULAR CORRELATIONS OF SEQUENTIAL PARTICLE DECAY FOR ALIGNED NUCLEI. Pronko, J. G. (Lockheed Palo Alto Research Lab., Calif.); Lindgren, R. A. Nucl. Instrum. Methods; 98: No. 3, 445-9(1972).

A convenient formulism in terms of a population parameter representation is presented for interpreting the angular correlations of sequentially decaying particles from aligned nuclei. Tables of coefficients representing these correlations are given for some cases. (2 figures, 2 tables) (auth)

24285 SOME SHORT-LIVED ISOTOPES OF LANTHANUM. Ohyoshi, Akira (Kumamoto Univ., Japan); Ohyoshi, Emiko; Tamai, Tadaharu; Shinagawa, Mutsuaki. Bull. Chem. Soc. Jap.; 44: No. 12, 3489(Dec 1971).

Lanthanum isotopes were separated from neutron-irradiated uranyl nitrate by the electromigration method with NTA. A Ge(Li) detector was used to study the γ spectra of the short-lived activities. Photopeaks at 0.619 and 0.644 MeV were assigned to ^{143}La and ^{142}La, respectively. An activity with a half-life of about 40 sec with photopeaks at 0.395 and 0.541 MeV was attributed to ^{144}La. (J.W.R.)

24286 LEVEL STRUCTURE OF THE LOW-LYING EXCITED STATES OF ^{116}Sn POPULATED BY THE RADIATIVE CAPTURE OF THERMAL NEUTRONS. McClure, D. A.; Lewis III, J. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 5: No. 3, 922-32(Mar 1972).

The low-lying excited states of ^{116}Sn populated by primary and secondary γ-ray transitions from the reaction ^{115}Sn(n,γ)^{116}Sn were studied. Both singles and $\gamma-\gamma$ coincidence techniques were employed with the exclusive use of Ge(Li) detectors. Results obtained from high-energy γ-ray spectra (~5.9 to 10 MeV) were combined with those from low-energy singles spectra (~100 keV to 3.8 MeV) and low-low coincidence spectra in order to infer the excitation energies and branching characteristics of 21 states up to an energy of ~3.7 MeV. A level and decay scheme is proposed including a total of 45 γ rays representing ~90% of the decay intensity. This scheme includes most of the levels having $E_x \leq 3$ MeV which were observed previously in charged-particle reactions and β-decay studies. The existence of the 0^+ level having an excitation energy of 2027 keV was confirmed, and a new level at 2545 keV excitation is proposed. (7 figures, 3 tables) (auth)

24287 (γ,p) REACTION ON ISOTOPES ^{112}Sn AND ^{124}Sn. Sorokin, Yu. I.; Khrushchev, V. A.; Yur'ev, B. A. (Moscow State Univ.). Yadern. Fiz.; 14: No. 6, 1118-22(Dec 1971). (In Russian).

Yield curves for photoprotons with energies higher than 1.8 MeV emitted from nuclei ^{112}Sn and ^{124}Sn are measured from threshold up to 29 MeV with 200-keV step using semiconductor silicon detec-

tors. The (γ,p)-reaction cross sections were calculated from the yield curves by means of the Penfold–Leiss method. The cross section curve for ^{112}Sn increases appreciably starting from 13 MeV, reaching the value of ~17 mb at the energy of ~18 MeV, and has a number of maxima in the region 14 to 27 MeV. The cross section for ^{124}Sn is nonzero only at >19.5 MeV and has maxima at 20.7, ~23, and 25.5 MeV. The integral cross sections of the (γ,p)—reaction amount to (129 ± 20) and (15 ± 3) mb · MeV for ^{112}Sn and ^{124}Sn, respectively. The obtained results are in qualitative agreement with the calculations based on the shell model with account of the isospin and residual interactions. (auth)

24288 COMPLETE FUSION NUCLEAR REACTIONS INDUCED BY KRYPTON IONS. EFFECTIVE THRESHOLD AND MINIMUM DISTANCE OF APPROACH FOR THE REACTIONS ^{116}Cd + ^{84}Kr AND ^{72}Ge + ^{84}Kr. Gauvin, H.; Le Beyec, Y.; Lefort, M.; Deprun, C. (Institut de Physique Nucleaire, Orsay, France). Phys. Rev. Lett.; 28: No. 11, 697-9(13 Mar 1972).

Effective energy thresholds were measured for the cross sections of complete fusion reactions induced by krypton ions with ^{116}Cd and ^{72}Ge. They show that the minimum distance of approach for the reaction is shorter than with lighter projectiles and corresponds to a Coulomb repulsion at a distance of $r_0(A_1^{\frac{1}{3}} + A_2^{\frac{1}{3}})$ fm with r_0 = 1.32 fm instead of 1.45 fm. (auth)

24289 EFFECT OF THE T = 1 PAIRING CORRELATIONS ON THE NUCLEAR DEFORMATION OF SOME EVEN-MASS-NUMBER Sn ISOTOPES. Bar-Touv, J. (Ohio State Univ., Columbus. Univ. of the Negev, Beer-Sheva, Israel); Struble, G. L. Phys. Rev., C; 5: No. 3, 773-9(Mar 1972).

The Hartree–Fock–Bogolyubov equations are solved for the even Sn isotopes between A = 112 and A = 124. The hypothesis that pairing restores spherical symmetry is critically examined, and the interplay of the pairing and single-particle degrees of freedom is discussed. (6 figures, 3 tables) (auth)

24290 DECAY OF ^{141m}Sm: A THREE-QUASIPARTICLE MULTIPLET IN ^{141}Pm. Eppley, R. E. (Michigan State Univ., East Lansing); Todd, R. R.; Warner, R. A.; McHarris, Wm. C.; Kelly, W. H. Phys. Rev., C; 5: No. 3, 1084-1103(Mar 1972).

The γ rays emitted following the decay of 22.1-min ^{141m}Sm were studied with Ge(Li) and NaI(Tl) detectors in various singles, coincidence, and anticoincidence configurations, including Ge(Li)–Ge(Li) two-dimensional "megachannel" coincidence experiments. Of the 47 γ rays definitely established as belonging to ^{141m}Sm decay, all but six very weak ones were placed in a consistent decay scheme. The energies in keV [and J^π assignments] of the states in ^{141}Pm populated by the decay of ^{141m}Sm are 0 [$5/2^+$], 196.6 [$7/2^+$], 628.6 [$11/2^-$], 804.5 [$11/2^+$, $5/2^+$], (837.1) [$5/2^+$], 974.0 [$5/2^+$], 1108.1 [$1/2^+$, $5/2^+$, ($5/2^-$)], 1167.2 [$13/2^-$,(+), $11/2^-$,(+), $5/2^-$,(+)], 1313.2 [$13/2^-$,(+), $11/2^-$,(+), $5/2^-$ +], 1414.8 [$11/2^-$, $5/2^-$], (1834.0) [$11/2^-$, $5/2^-$], 1983.1 [$5/2^-$], 2063.5 [$11/2^-$, $5/2^-$], 2091.6 [$11/2^-$, $5/2^-$], 2119.0 [$11/2^-$, $5/2^-$], and 2702.4 [$13/2^-$, $11/2^-$, $5/2^-$]. Less than 0.2% of the decay of ^{141m}Sm proceeds via an M4 isomeric transition to 11.3-min ^{141g}Sm. Two-thirds of the ^{141m}Sm electron-capture decay goes to the six (possibly seven) highest-lying states in ^{141}Pm, another example analogous to ^{139m}Nd decay of the population of a well-defined three-quasiparticle multiplet by an N = 79 nuclide. In simple shell-model terms this can be written as $(\pi d_{\frac{5}{2}})^2(\nu d_{\frac{5}{2}})^{-2}(\nu h_{\frac{11}{2}})^{-1} \rightarrow (\pi d_{\frac{5}{2}})(\nu d_{\frac{5}{2}})^{-1}(\nu h)^{-1}_{\frac{11}{2}}$. Most of the remaining states can be characterized quite satisfactorily as specific single-particle and core-coupled states. The behavior of these states allows a considerable addition to the systematics of shell-model orbits and their occupations in this region below N = 82. (13 figures, 6 tables) (auth)

24291 HIGH-SPIN LEVELS OF ^{92,93,94,95,96}Nb AND ^{94}Tc POPULATED WITH (α,d) AND (α,t) REACTIONS AT 50 MeV. Zisman, M. S.; Harvey, B. G. (Univ. of California, Berkeley). Phys. Rev., C; 5: No. 3, 1031-49(Mar 1972).

The reactions ^{91,92,94}Zr(α,t)^{92,93,95}Nb, ^{90,91,92,94}Zr(α,d)^{92,93,94,96}Nb, and ^{92}Mo(α,d)^{94}Tc were investigated with a 50-MeV α-particle beam from the Berkeley 88-in. cyclotron. High-spin proton excited states observed in the (α,t) reaction, based on comparisons with (^{3}He,d) experiments on the same targets, include ^{92}Nb(≈5-MeV multiplet); ^{93}Nb(1.08, 1.29, ≈4.5 MeV); and ^{95}Nb(1.27, 1.65, 2.10 MeV). Two groups of strongly excited states appear in the (α,d) data. Members of the lower group [^{92}Nb(g.s.), ^{94}Nb(0.08 MeV), and ^{96}Nb (0.23 MeV)] were previously identified as being $\pi g_{\frac{9}{2}}, \nu d_{\frac{5}{2}})_{7^+}$ states. Based on results from the ^{92}Mo(α,d)^{91}Tc experiment, the ^{94}Tc ground state can also be assigned 7$^+$. The higher levels [^{92}Nb(2.58 MeV), ^{94}Nb(2.42 MeV), ^{96}Nb(2.38 MeV), and ^{94}Tc(2.68 MeV)] are believed to be either $(\pi g_{\frac{9}{2}}, \nu g_{\frac{9}{2}})_{8^+}$ or $(\pi g_{\frac{9}{2}}, \nu h_{\frac{11}{2}})_{10^-}$ states is a result of shell-model matrix-element calculations and the (α,d) structure factors of Glendenning. (19 figures, 15 tables). (auth)

24292 ENERGY LEVELS OF ^{104}Pd POPULATED BY THE β^- DECAY OF 43-SEC ^{104g}Rh AND 4.41-min ^{104m}Rh. Singhal, N. C. (Oak Ridge National Lab., Tenn.); Johnson, Noah R.; Eichler, E.; Hamilton, J. H. Phys. Rev., C; 5: No. 3, 948-58(Mar 1972).

The β decay of 43-sec and 4.41-min ^{104}Rh was investigated with a high-resolution Ge(Li) detector. In addition to the 16 γ rays reported earlier, three new γ rays of energies 839.90, 1264.84, and 1689.1 keV were observed. The γ rays belonging to the 43-sec and 4.41-min decays were identified. With the help of Ge(Li)–Ge(Li) two-parameter coincidence measurements, all 19 of the γ rays assigned to the ^{104}Rh decay were fitted into 11 excited states of ^{104}Pd at 555.81, 1323.59, 1333.58, 1341.68, 1792.86, 1793.83, 1820.65, 2082.38, 2181.58, 2244.9, and 2265.31 keV and one excited state in ^{104}Ru at 358.12 keV. The energy levels at 1323.59, 1333.58, 1341.68, and 1792.86 keV were assigned unique spin values of 4, 0, 2, 0, respectively, from the results of NaI–Ge(Li) directional-correlation measurements. (7 figures, 6 tables) (auth)

24293 GAMMA-RAY MULTIPLICITY IN THE DECAY OF RESIDUAL NUCLEI FROM NUCLEAR REACTIONS. Degnan, J. H.; Cohen, B. L.; Petty, R. C.; (and others) (Univ. of Pittsburgh). Phys. Rev., C; 5: No. 3, 836-45(Mar 1972).

A technique was developed for measuring the average number of γ rays, N_γ, emitted in the decay of residual nuclei left by specific nuclear reactions as a function of excitation energy. It was used with (p,p′) reactions induced by 17- and 12-MeV protons and with (d,p) reactions induced by 12-MeV deuterons, each with seven target nuclei of different types. N_γ increases with excitation energy up to 10 MeV, and is generally below 4 in this range. Variations between light and heavy nuclei; between (d,p) and (p,p′) reactions; between (p,p′) reactions at 17 and at 12 MeV; between odd–even, even–odd, and even–even nuclei in the same mass and energy regions, etc. were investigated, and their interpretations are discussed. (8 figures, 1 table) (auth)

24294 DELAYED NEUTRON EMISSION FROM ^{137}I. Shalev, S.; Rudstam, G. (Swedish Research Council's Lab., Studsvik, Sweden). Phys. Rev. Lett.; 28: No. 11, 687-90(13 Mar 1972).

The β-delayed neutron energy spectrum from ^{137}I was studied with a high-resolution neutron spectrometer. The neutron energy distribution is found to exhibit prominent line structure. The overall shape of the distribution indicates that γ-ray emission strongly competes with d-wave neutron emission over a large excitation-energy interval. The line structure is shown to be in general agreement with spin-dependent level-density calculations. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 23446, 24224, 24265, 24272, 24276, 24279–24280, 24284, 24310, 24313, 24318–24320, and 24368.

24295 (ORO-3820-14) ON-LINE ALPHA AND PROTON DECAY SPECTROMETRY. Annual Progress Report, 1971. Macfarlane, Ronald D. (Texas Agricultural and Mechanical Univ., College Station). 15 Jan 1972. Contract AT(40-1)-3820. 16p. Dep. NTIS.

Work concentrated on the helium-jet recoil transport method and beta and beta-delayed alpha decays of ^{20}Na. The first known measurement of the energy spectrum of a ground-state α emitter was achieved with the MAGGIE recoil time-of-flight mass analyzer. Abstracts of papers submitted for publications are included. (2 figures) (R.W.R.)

24296 (UCRL-Trans-10559) MEASUREMENT OF THE ANGULAR DISTRIBUTION OF NEUTRON-CAPTURE GAMMA RAYS FROM POLARIZED ^{159}Tb NUCLEI. Bosch, D. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Z. Phys.; 239: 57-72(1970). 20p. Dep. NTIS.

The anisotropy of high-energy capture γ rays from polarized ^{159}Tb nuclei was measured. Polarization of ^{159}Tb was achieved by cooling single crystals of terbium ethyl sulfate to T = 0.35°K in an external field of 4 kOe. From the results of this measurement, it was possible to deduce the spins of 11 levels in ^{160}Tb between 64 and 767 keV. Furthermore the Q-value for the reaction ^{159}Tb(n,γ)^{160}Tb was found to be Q = (6,374.0 ± 1.5) keV. (auth)

24297 E2 AND M1 TRANSITION PROBABILITIES BETWEEN LOW-ENERGY STATES IN ^{189}Ir. Baecklin, A. (Swedish Research Councils' Lab., Nykoeping); Hedin, G.; Berg, V.; Malmskog, S. G. Nucl. Phys.; A181: No. 1, 76-96(1972).

Half-lives have been measured for the lowest excited states in ^{189}Ir and the transitions between the states have been studied using high-resolution electron and γ-spectroscopy. The following half-lives were obtained: 94.34 keV, 11.6 ± 0.6 nsec; 113.82 keV, 76 ±

18 psec; 176.53 keV, 22 ± 10 psec; 300.51 keV, <20 psec. A new transition was found at 62.65 keV. From L subshell ratios the following multipolarity mixtures were obtained: 62.65 keV, M1 + $(8.5^{+\infty}_{3})$% E2; 71.69 keV, M2; 82.22 keV, M1 + (2.8 ± 0.7)% E2; 94.34 keV, E2 + (5.5 ± 1.0)% M1; 113.82 keV, M1 + (23 ± 2)% E2; 141.18 keV, M1 + $(1.5^{+\infty}_{1.0})$% E2; 176.53 keV, M1 + (44 ± 3)% E2; 186.70 keV, M1 + (21 ± 4)% E2; 203.78 keV, M1 + <30% E2; 223.24 keV, E2; 243.50 kev, E2; 258.37 keV, E3; 300.51 keV, E2; 317.65 keV, M1 + (23 ± 10)% E2. Reduced E2 and M1 transition probabilities are calculated and compared to the result of a two-band Coriolis coupling calculation. A deformation parameter $\delta = 0.23$ is obtained in ^{189}Ir. This represents a sharp increase from the value $\delta = 0.12$ obtained in ^{191}Ir and ^{193}Ir. The B(E2) and B(M1) values in all odd-A Ir nuclei are presented systematically and compared to current nuclear models. (auth)

24298 SUDDEN CHANGE IN THE NUCLEAR CHARGE DISTRIBUTION OF VERY LIGHT MERCURY ISOTOPES. Bonn, J.; Huber, G.; Kluge, H.-J.; Kugler, L.; Otten, E. W. (CERN, Geneva Univ., Heidelberg). Phys. Lett.; 38B: No. 5, 308-11 (6 Mar 1972).

The following quantities were determined by optical pumping with the spectral line 2537 Å: for ^{183}Hg: I = ½, μ_I = 0.513(9) nm, isotopic shift (^{183}Hg − ^{204}Hg) = 18.9(8) GHz; for ^{185}Hg: I = ½, μ_I = 0.449(4) nm, isotopic shift (^{185}Hg − ^{204}Hg) = 19.2(4) GHz. The isotopic shifts for ^{183,185}Hg deviate very strongly from an extrapolation from the heavier mercury isotopes (including ^{187}Hg). This duration indicates that a large increase in the effective nuclear volume of Hg occurs in going from N = 107 to N = 105. (auth)

24299 M1 ADMIXTURES OF TRANSITIONS IN ^{156}Gd. Hamilton, J. H. (Vanderbilt Univ., Nashville); Little, P. E.; Ramayya, A. V.; (and others). Phys. Rev., C; 5: No. 3, 899-910(Mar 1972).

$\gamma-\gamma$ directional-correlation measurements were carried out with a NaI-Ge(Li) detector system on the transitions in ^{156}Gd whose levels are populated from the decay of ^{156}Eu. Directional correlations of the 88.95-keV γ ray with 11 transitions which directly feed and 4 which involve a skipped transition to the 88.95-keV state were simultaneously measured. A δ value of $-5.9^{+\infty}_{2}$ was measured for the 1040.44-keV, $2^+_\beta \rightarrow 2^+_g$ transition, which is thus $(97.2^{+\infty}_{2.5})$% E2. The 1065.14-keV, $2^+_\gamma \rightarrow 2^+_g$ transition has a $\delta = -18 \pm 3$ and a (99.7 ± 0.1)% E2 component. Three $1^+ \rightarrow 2^+_g$ transitions of 1877.03, 1937.71, and 2097.70 keV have E2 admixtures of $(13.8^{+\infty}_{2.9})$, $(24.5^{+\infty}_{1.9})$, and $(59.0^{+\infty}_{3.0})$%, respectively, while the 811.77-keV, $1^+ \rightarrow 2^+_\gamma$ transition is $(0.1^{+\infty}_{0.1})$% E2. (7 figures, 3 tables) (auth)

24300 THEORETICAL ALPHA DECAY RATES OF PLATINUM, GOLD, AND MERCURY ISOTOPES. Carjan, N.; Holan, S.; Sandulescu, A.; Sabac, C. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 10, 1175-85(1971).

In the framework of the R matrix formulation of the theory of alpha decay, recent data concerning the α-active isotopes of mercury, gold, and platinum are analyzed by using the shell model. The penetrabilities were computed exactly by solving numerically the Schröedinger equation. The comparison between the experimental and theoretical alpha reduced widths shows that the shell model with pure configurations and harmonic oscillator wave functions describes relatively well the variation of the alpha widths with neutron number, but that the theoretical alpha reduced widths are smaller than the experimental ones by 7 orders of magnitude. A new theory of alpha decay which is not radius dependent is apparently needed. (3 figures, 3 tables) (auth)

24301 EXPERIMENTS ON PARITY NONCONSERVATION IN NUCLEAR FORCES. III. GAMMA TRANSITIONS IN ^{180}Hf, ^{159}Tb, ^{181}Ta, ^{203}Tl, and ^{182}W. Lipson, E. D.; Boehm, F.; Vanderleeden, J. C. (California Inst. of Tech., Pasadena). Phys. Rev., C; 5: No. 3, 932-41(Mar 1972).

Studies of the parity admixtures in nuclear γ transitions were continued by measuring the circular polarization of γ rays from five nuclei with a technique different from that of parts I and II in this series. The experiments were performed with a forward-scattering rapidly reversing Compton polarimeter and a phase-sensitive detection system. The analyzing efficiency of the Compton polarimeter, including effects of multiple scattering, was determined by Monte Carlo calculations. It was necessary in most experiments to apply corrections for polarized bremsstrahlung associated with β decays. Calculations of bremsstrahlung effects were verified by experiments on ^{198}Au and ^{177}Lu. The residual asymmetry of the polarimeter itself was determined by control experiments on ^{103}Ru. The values of P_γ obtained were as follows: ^{180}Hf, 501 keV, $P_\gamma = (-23 \pm 6) \times 10^{-4}$; ^{159}Tb, 363 keV, $P_\gamma = (-1 \pm 5) \times 10^{-4}$; ^{203}Tl, 279 keV, $P_\gamma = (-0.04 \pm 0.10) \times 10^{-4}$; ^{181}Ta, 482 keV, $P_\gamma = (-0.031 \pm 0.025) \times 10^{-4}$; and ^{182}W, 1189 keV, $P_\gamma = (-0.25 \pm 0.40) \times 10^{-4}$. A survey and a discussion of these results are presented. (auth)

24302 APPLICATION OF STATISTICAL TESTS FOR SINGLE-LEVEL POPULATIONS TO NEUTRON-RESONANCE-SPECTROSCOPY DATA. Liou, H. I.; Camarda, H. S.; Rahn, F. (Columbia Univ., New York). Phys. Rev., C; 5: No. 3, 1002-15 (Mar 1972).

Dyson's new F-statistic test for spurious or missing levels was applied to recent ^{166}Er data and other results. The F test was shown to give good agreement with the ^{166}Er total observed level set and the l = 0 population choices for ^{168}Er and ^{170}Er, which were made before this test was known. The F test involves the evaluation, at each resonance position, E_i, of a parameter F_i, defined as $F_i \equiv \Sigma_{j \neq i} f(x_{ji})$, where $x_{ji} = (E_j - E_i)/L$, j is summed over all resonances between $(E_i - L)$ and $(E_i + L)$, and $f(x) = \frac{1}{2} \ln\{[1 + (1-x^2)^{1/2}]/[1-(1-x^2)^{1/2}]\}$ for $x < 1$. The interval $L = M\langle D \rangle$ is characterized by a properly chosen integer, M. Dyson finds that $\langle F_i \rangle = n - \ln(n) - 0.656$, with a standard deviation of $[\ln(n)]^{1/2}$, where $n = \pi M$. If a spurious level is present, $\langle F_i \rangle = n$, evaluated at the spurious level. Thus, a large positive fluctuation occurs at a spurious level, while a low value of F_i results near a missed level. The F test and other statistical tests were used to see if sets of l = 0 resonances which agree with the Porter-Thomas (PT) distribution for $(\Gamma^0_n)^{1/2}$ and all statistical level-ordering tests could be chosen for ^{232}Th and ^{238}U. For the ^{232}Th and ^{238}U we used our older data for Γ^0_n values and for the positions of the stronger s levels. Our more recent 1970 data for these isotopes were used to better establish the position of the weak levels. It should be emphasized that ≥80% of the final choice s population is made of stronger s levels having Γ^0_n values too large to be p levels. The only degree of freedom is for the s-level selection from the weaker s + p levels observed. The number of weak "s" levels chosen is determined by the PT distribution; and attempts were made to fit (simultaneously) the Wigner nearest-neighbor spacing distribution, $\rho(S_j, S_{j+1}) \cong -0.27$, the Dyson-Mehta Δ statistic, and the Dyson F test. For both isotopes, good simultaneous fits were obtained. This result is highly unlikely unless the "true" s population satisfied the tests, since ≥80% of the final choice involves nonweak s levels. (7 figures, 5 tables) (auth)

24303 ANALYSIS OF THE DISTRIBUTION OF THE SPACINGS BETWEEN NUCLEAR ENERGY LEVELS. II. Monahan, James E. (Argonne National Lab., Ill.); Rosenzweig, Norbert. Phys. Rev., C; 5: No. 3, 1078-83(Mar 1972).

The statistic $\Lambda(n)$, previously defined for the purpose of comparing empirical distributions of energy-level spacings with theoretical distributions, is applied to the recently published series of neutron-capture levels observed in the even-A erbium isotopes. When the empirical values of $\Lambda(n)$ in the energy range of the highest experimental resolution were averaged over all possible sets of n successive spacings, the resulting value $\Lambda^*(n)$ is found to decrease sharply with increasing values of n. This decrease is consistent with that of the expectation value $\langle \Lambda(n) \rangle$ calculated for Wigner's Gaussian orthogonal ensemble of real symmetric matrices. (5 figures). (auth)

24304 NUCLEAR STRUCTURE AND PARITY MIXING IN THE DECAYS FROM ORIENTED ^{182}Ta. Krane, K. S.; Sites, James R.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 3, 1104-13(Mar 1972).

Angular distributions of 26 γ rays in ^{182}W were measured following the β decay of ^{182}Ta oriented at low temperatures in iron. Triple multipole mixing (E1 + M2 + E3) of the 1189-keV γ radiation was inferred by comparison of the present results with those of $\gamma-\gamma$ directional correlations and internal-conversion measurements; values deduced for the mixing ratios of the 1189-keV radiation were $\delta(M2/E1) = +0.49 \pm 0.03$ and $\delta(E3/E1) = -0.64 \pm 0.05$. E2/M1 multipole mixing ratios deduced for other γ transitions were (energies in keV) as follows: $\delta(85) = -0.30 \pm 0.02$; $\delta(114) = +0.31 \pm 0.02$; $\delta(179) = +0.92^{+\infty}_{0.07}$; $\delta(1002) = -(8.9^{+\infty}_{1.0})$; $\delta(1121) = +21^{+19}_{-6}$; $\delta(1157) = -(7.6^{+\infty}_{-4.8})$; $\delta(1231) = -(60^{+100}_{-20})$. The M2/E1 mixing ratios deduced were $\delta(222) = +0.007 \pm 0.005$ and $\delta(1274) = +0.42 \pm 0.04$. The E3/M2 mixing ratio of the 960-keV transition was deduced to be $-3.6 \leq \delta(960) \leq -0.3$. The allowed β transition populating the 1374-keV level was determined to be (38 ± 23)% Fermi (L = 0) and (62 ∓ 23)% Gamow-Teller (L = 1). In the first-forbidden β transition populating the 1443-keV level, probably all, but at least half, of the β transitions carry one unit of angular momentum, with the remainder carrying two units. The hyperfine splitting of ^{182}Ta in iron was found to be 21 ± 2 mK, corresponding to a ^{182}Ta ground-state magnetic moment of 2.6 ± 0.2μ_N. Measurements of the parity-nonconserving 0-180° (forward-backward) asymmetry of the 1189-keV γ-ray angular distribution indicated an asymmetry of $(-2.8 \pm 1.7) \times 10^{-4}$; vanishing asymmetries were found for the 222-, 1121-, and 1274-keV γ rays. These results would seem to be in reasonable agreement with the vanishing circular polarization of the ^{182}W γ rays measured elsewhere. (5 figures, 4 tables) (auth)

24305 NEUTRON-RESONANCE SPECTROCOPY. VIII. THE SEPARATED ISOTOPES OF ERBIUM: EVIDENCE FOR DYSON'S THEORY CONCERNING LEVEL SPACINGS. Liou, H. I.; Camarda, H. S.; Wynchank, S.; (and others) (Columbia Univ., New York). Phys. Rev., C; 5: No. 3, 974-1001(Mar 1972).

Results are given for high-resolution neutron-resonance-spectroscopy studies of the separated erbium isotopes (164, 166, 167, 168, 170) using the Nevis Synchrocyclotron. These results, particularly ^{166}Er to 4200 eV (n = 109 levels), give the first excellent agreement with the Dyson–Mehta (DM)Δ statistic which applies for the statistical orthogonal ensemble (O.E.) of Wigner and Dyson. The observed ^{166}Er levels seem to be a nearly pure and complete s population, fitting Wigner's nearest-neighbor spacing law and the Porter–Thomas (PT) single-channel Γ_n^0 distribution. The weakest ^{168}Er and ^{170}Er levels include some p levels (excess of weak Γ_n^0 values), which are separated by a Bayes-theorem method; the method yields s populations which also give good fits to all statistical O.E. tests. Unexpectedly, the ^{166}Er levels give a nonzero correlation coefficient between adjacent Γ_n^0 values of $\rho(\Gamma_{nj}^0, \Gamma_{nj+1}^0) = -0.21 \pm 0.08$, with less fluctuation in $\Sigma\Gamma_n^0$ over adjacent intervals than expected for an uncorrelated PT series of Γ_n^0 values. Under the assumption of a true p-level density 3 times that for s levels, S_1 values are calculated on the basis of the observed excess of weak levels and the known level detection threshold. The results obtained are $10^4 S_0$ = 1.70 ± 0.23, 1.89 ± 0.20, 1.50 ± 0.21, and 1.54 ± 0.22 for the isotopes 166, 167, 168, 170 and $10^4 S_1$ = ≤0.75, 0.70 ± 0.20, 0.80 ± 0.25 for 166, 168, 170. Values found for Δ are Δ = 0.455 (n = 109) for ^{166}Er, 0.287 (n = 50) for ^{168}Er, and 0.359 (n = 31) for ^{170}Er; these are in contrast with DM's predicted Δ = 0.47 ± 0.11, 0.39 ± 0.11, and 0.34 ± 0.11. For a large n, Δ is much larger for an uncorrelated Wigner (U.W.) spacing sequence or for an incomplete or impure s level O.E. set. The correlation coefficient for adjacent spacings, $\rho(S_j, S_{j+1}) \equiv \rho$, = −0.22, −0.29, −0.09 for 166, 168, 170 vs $\rho \approx -0.27$ (±0.09), 0.13, 0.17 for 166, 168, 170 (O.E.). The probability is 0.0004 for $[\Delta + \rho] \leq$ the ^{166}Er (4.2-keV) value for a U.W. set. The ⟨D⟩ values for s levels, if the s level count is correct, are 38.4, 4.06, 95.3, and 155 eV [±0.9/n fractional uncertainty (O.E.)] for n = 109, 30, 50, and 31 for 166, 167, 168, and 170. (15 figures, 16 tables) (auth)

24306 DECAY OF A NEW 5.8-MIN ^{150}Tb ACTIVITY. Haenni, D. R.; Sugihara, T.; Bowman, W. W. (Texas A and M Univ., College Station). Phys. Rev., C; 5: No. 3, 1113-21(Mar 1972).

A new short-lived isomer of ^{150}Tb was identified. The mass assignment was confirmed by excitation functions and cross bombardments. The 5.8 ± 0.2-min activity is probably a 9^+ state ($\pi h_{9/2} \nu f_5$) and decays chiefly to an (8^+) state at 2554.4 keV in ^{150}Gd with a log-ft value of 4.1. No isomeric transition to the 3.1-h ^{150}Tb was observed. The γ-ray spectrum was investigated with Ge(Li) detectors. The 19 γ rays observed were assigned to 10 excited levels (in keV) at 638.05, 2^+; 1134.35, 3^-; 1288.4, (4^+); 1700.9, (5^-); 1936.8, (6^+); 2116.1, (6^+); 2211.2, (7^-); 2392.5; 2554.4, (8^+); and 2906.0. The energy spacing of the positive-parity states in ^{150}Gd suggests a close correspondence to a vibrator model, although low-spin members of multiplets corresponding to multiphonon states are not observed. The quasi-band representation of Sakai appears also to be a useful way of interpreting these states. Three negative-parity states form a sequence, which may correspond to a combination of octupole and quadrupole phonons or an octupole quasi-band. (8 figures, 2 tables) (auth)

24307 DEFORMATION ENERGIES OF W, Os, Pt, AND Hg ISOTOPES FOR β_2-, β_4-, AND γ-DISTORTIONS. Goetz, U. (Univ., Basel); Pauli, H. C.; Alder, K.; Junker, K. Phys. Lett.; 38B: No. 5, 274-6(6 Mar 1972).

The importance of β_4 deformations for the stability of the equilibrium shapes of W and Os isotopes is demonstrated. For Pt and Hg isotopes with mass numbers around A = 200 a second minimum at $\beta_2 \approx 0.45$ and $\gamma = 0°$ is found. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 23454, 24254, 24265–24266, 24268, 24282, 24293, 24301, 24307, 24317, 24319–24320, 24336, 24368, and 24647.

24308 NUCLEAR LEVEL SCHEME OF ^{198}Au FROM DOUBLE NEUTRON CAPTURE IN GOLD. Breitig, D. (Technical Univ., Munich. Research Establishment, Risoe, Denmark). Z. Naturforsch.; 26a: No. 11, 1928-9(Nov 1971).

The γ spectra from double neutron capture by ^{197}Au were studied with a bent crystal spectrometer. A level scheme for ^{198}Au was developed and compared with the level scheme established from ^{198}Pt decay studies. (J.W.R.)

24309 THREE-QUASIPARTICLE EXCITATIONS IN ^{205}At. Hagemann, U.; Neubert, W.; Schulze, W.; Stary, F. (Joint Inst. for Nuclear Research, Dubna, Moscow). Nucl. Phys.; A181: No. 1, 145-52(1972).

In the reaction ^{197}Au(^{12}C,4n)^{205}At an isomeric state with a half-life $T_{\frac{1}{2}}$ = 110 ± 25 ns was observed, which is ascribed to the $2\frac{1}{2}^-$ state of the $p(h_{\frac{9}{2}})^3$ multiplet. Compared to the corresponding nucleus ^{211}At this multiplet is not well developed, because the unfilled neutron shell causes a configuration mixing with the two-neutron states. (auth)

24310 CROSS SECTIONS OF THE (n,2n)-REACTIONS FOR ISOTOPES OF THULIUM, IRIDIUM, THALLIUM, AND LEAD AT THE INCIDENT NEUTRON ENERGY OF 14.8 MeV. Druzhinin, A. A.; Ivanova, N. I.; Lbov, A. A. Yadern. Fiz.; 14: No. 4, 682-4(Oct 1971). (In Russian).

Cross sections of the (n,2n)-reactions at the neutron energy of 14.8 MeV are measured for the Tm, Ir, Tl, and Pb isotopes by means of the activation method. The cross sections are found to be: $\sigma_{n,2n}(^{169}\text{Tm}) = 1630 \pm 160$ mb, $\sigma_{n,2n}(^{193}\text{Ir}) = 1630 \pm 160$ mb, $\sigma_{n,2n}(^{203}\text{Tl}) = 1700 \pm 170$ mb, $\sigma_{n,2n}(^{204}\text{Pb}) = 2200 \pm 200$ mb. The obtained results are compared with data by other authors and with calculations. The cross section for ^{193}Ir is obtained for the first time. (auth)

24311 PRECISION DETERMINATION OF HIGH-Z K-SHELL FLUORESCENCE YIELDS FROM ^{195}Au, ^{207}Bi, AND ^{235}Np DECAYS. Hansen, J. S. (Georgia Inst. of Tech., Atlanta); McGeorge, J. C.; Fink, R. W.; (and others). Z. Phys.; 249: No. 5, 373-85(1972).

A new method utilizing a cooled, high resolution, windowless Si(Li) x-ray and Auger electron detector has been developed for the accurate measurement of high-Z K-shell fluorescence yields. With this method, values of the K-fluorescence yield ω_K have been determined with high accuracy at Z = 78, 82, and 92 from radioactive decay of carrier-free ^{195}Au, ^{207}Bi, and ^{235}Np, respectively. The values of ω_K are 0.968 ± 0.008, 0.972 ± 0.008, and 0.970 ± 0.005, respectively where the error limits represent 95% confidence. In addition, relative K-Auger electron group intensities at Z = 92 were measured and found to be (K–LL) : (K–LX) : (K–XY) = 100 : (65.2 ± 6.0) : (8.1 ± 0.8). The experimental results for ω_K are compared with the relativistic calculations of Bhalla, Ramsdale and, Rosner, and satisfactory agreement is found. (auth)

24312 ALTERNATE MODELS OF PARTICLE–CORE COUPLING IN ^{209}Bi. Cleary, T. P. (Yale Univ., New Haven); Callender, W. D.; Stein, N.; (and others). Contract AT(11-1)-3074. Phys. Rev. Lett.; 28: No. 11, 699-702(13 Mar 1972).

Energy levels in ^{209}Bi excited by nonresonant scattering of 16.10-MeV protons are compared with levels reached by scattering from a group of isobaric analog resonances at E_p = 14.95 MeV. The nonresonant results are sensitive to the parentage of ^{208}Pb core excitations in the levels of ^{209}Bi, while the resonant data provide information about the ^{210}Bi parentage. (auth)

24313 SEARCH FOR SPONTANEOUS-FISSION ISOMERISM IN NUCLEI OF T MEDIUM MASS. Alexander, John M.; Bimbot, Rene Institut de Physique Nucleaire, Orsay, France). Phys. Rev., C; 5: No. 3, 799-804(Mar 1972).

Spontaneous-fission isomers were searched for among the recoil products from the following reactions: ^{209}Bi + ^{1}H, ^{209}Bi + ^{2}H, ^{209}Bi + ^{4}He, Pb + ^{3}H, ^{206}Pb + ^{4}He, Ir + ^{14}N, ^{169}Tm + ^{14}N, ^{154}Gd + ^{4}He, and ^{141}Pr + ^{14}N. The major products were $^{198-208}$Po, $^{199-208}$Bi, $^{149-151}$Dy, At, and Os. In no case were isomers observed unambiguously. Limiting cross sections for fission isomers are $\approx 10^{-31}$ to 10^{-33} cm^2, while product cross sections are 10^{-24} to 10^{-25} cm^2. The limiting isomer ratios are $\approx 10^{-6}$ to 10^{-8} for decay periods of a fraction of a nanosecond to many hours. These ratios are generally less than ≈1 to 0.01% of the corresponding ratios for fission isomers in heavier nuclei. (3 figures, 2 tables) (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 23452, 23700, 24254, 24288, 24302, 24311, 24336, 24368, 24370, 24373, and 25009.

24314 (ANCR-1044) ^{235}U RESOLVED RESONANCE PARAMETERS FOR ENDF/B, VERSION III. Smith, J. R.; Young, R. C. (Aerojet Nuclear Co., Idaho Falls, Idaho). Dec 1971. Contract AT(10-1)-1375. 53p. (ENDF-161). Dep. NTIS.

A new set of resolved resonance parameters for ^{235}U was derived for inclusion in Version III of the Evaluated Nuclear Data

File B. Single-level parameters plus a complementary smooth file describe the cross sections between 7 and 82 eV. The parameters were developed by simultaneously fitting three sets of fission cross section data and one set each of total and capture cross sections. The Automated Cross Sections Analysis Program (ACSAP) was used in the fitting. (auth)

24315 (ANCR-1045) EVALUATION OF THE ^{239}Pu CROSS SECTIONS IN THE RESONANCE REGION FOR THE ENDF/B VERSION III DATA FILE. Simpson, O. D.; Simpson, F. B. (Aerojet Nuclear Co., Idaho Falls, Idaho). Dec 1971. Contract AT-(10-1)-1375. 91p. (ENDF-162). Dep. NTIS.

An evaluation of the ^{239}Pu neutron cross sections has been completed from 1 – 300 eV. Total, fission and capture data were used in the evaluation to produce a set of single-level resonance parameters. Smooth files are included because the single-level parameters will not describe the cross sections of a fissile nucleus. Techniques used in the evaluation are discussed and figures showing the theoretical fits to the various sets of experimental data are shown. (auth)

24316 (BNL-tr-464) STRENGTH FUNCTIONS OF ^{235}U AND ^{239}Pu FOR s- AND p-NEUTRONS. Ryabov, Yu. V.; Fenin, Yu. I. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 13: No. 7, 1039-41(1971). 5p. Dep. NTIS.

An analysis was performed of the average total cross section for fission and radiative capture of neutrons by ^{235}U and ^{239}Pu in the energy region 0.1 to 30 keV. The strength functions S_0 and S_1 were calculated for ^{235}U and ^{239}Pu by the least-squares method using a computer, with allowance for the small corrections for neutron scattering via the compound nucleus. The values of S_0 agree with those obtained in an analysis of allowed resonances in the energy region up to 100 eV. (auth)

24317 (COO-3463-3) STATISTICAL THEORY OF ISOMER RATIOS FOR SHAPE (FISSION) ISOMER IN (n,γ) REACTIONS. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). [1971]. 18p. Dep. NTIS.

A statistical theory is developed for the evaluation of isomer ratios for shape isomers. The method described in its present form is applicable for the calculation of isomer ratios in (n,γ) reactions. The method is used for the analysis of the isomer ratio for the reactions using as target ^{241}Am, ^{233}U, ^{235}U, and ^{239}Pu. In most cases good agreement between theory and experiment is obtained. (1 table) (auth)

24318 (INDC(CCP)-15/U) NUCLEAR PHYSICS RESEARCH IN THE USSR (COLLECTED ABSTRACTS) NO. 10. (International Nuclear Data Committee). 1970. 59p. Dep. NTIS (U. S. Sales Only).

Twenty-three abstracts on experimental research on nuclear physics in the USSR are presented. (J.F.P.)

24319 (JINR-P4-6150) POSSIBLE STUDY OF THE FISSION BARRIER VALUE IN THE DIRECT TYPE REACTIONS BETWEEN COMPOUND NUCLEI. Kalinkin, B. N.; Permyakov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The question is studied of which experiments can most simply give information about the fission barrier for arbitrary nuclei (not only fissioning). With this aim in view it is suggested using the form of the mass distribution of the fission fragments and the model, which is based on the inelastic shock mechanism. (auth)

24320 (LA-4789) NEUTRON PRODUCTION BY MEDIUM-ENERGY PROTONS ON HEAVY METAL TARGETS. Fullwood, R. R.; Cramer, J. D.; Haarman, R. A.; Forrest, R. P. Jr.; Schrandt, R. G. (Los Alamos Scientific Lab., N. Mex.). Jan 1972. Contract W-7405-eng-36. 27p. Dep. NTIS.

Neutron production resulting from medium-energy proton bombardment of heavy metal targets was calculated by Monte Carlo methods for cylinders and a sphere as a function of time, angle, and position. With one exception (550 MeV), all calculations were for 800-MeV proton energy and for targets of ^{238}U, lead, tantalum and a ^{238}U – ^{235}U composite. Gamma-ray production was calculated by a simplified model and the results were compared with those of Alsmiller and Moran for γ-ray production for a 150-MeV electron bombardment of Ta. The ratio of escaping neutrons per incident proton (n/p) varied from 38.5 to 16.7 depending upon the target. The results reported here give n/p ratios for uranium about 25% lower than that reported by the workers on the Canadian Intense Neutron Generator (ING) project. Ninety percent of the evaporation neutrons that serve as the source for the low-energy neutron transport are produced within a 0.75-cm radius of the beam and have an axial distribution so that 63% are contained within a 12.3-cm length. This fact is manifest through the comparative insensitivity of neutron production to target geometry. The most probable energy for the escaping neutrons from the large targets is about 0.2 MeV resulting from the degradation of the evaporation spectrum by neutron inelastic and multiple production processes. For the large ^{238}U targets, there was one escaping photon for every 12 escaping neutrons. This low ratio is a consequence of the strong photon absorption in the target and the mechanism of neutron production. Because the efficacy of this neutron production method depends on the strength of available proton sources, a comparison is made of a proposed facility time-sharing the beam of the Los Alamos Meson Physics Facility (LAMPF), the improved Columbia University Nevis Cyclotron's expected performance, and the Oak Ridge National Laboratory Electron Linear Accelerator (ORELA). (auth)

24321 (LBL-255) PROMPT GAMMA RAY SPECTRA FROM PRODUCTS FORMED IN THE SPONTANEOUS FISSION OF ^{252}Cf. Wilhelmy, J. B.; Cheifetz, E.; Jared, R. C.; Thompson, S. G. (California Univ., Berkeley. Lawrence Berkeley Lab.). 30 Nov 1971. Contract W-7405-eng-48. 66p. Dep. NTIS.

We present information on how to obtain and use a magnetic tape on which is recorded gamma ray spectral information in coincidence with the prompt fission of ^{252}Cf. This data is supplied so that interested users may have access to a large number and variety of gamma ray spectra sorted according to fragment mass intervals. The information was recorded in three and four parameter experiments in which two fragment kinetic energies were measured in coincidence with gamma rays and K x-rays. (auth)

24322 (ORNL-TM-3482) TESTING OF ^{238}U SECONDARY GAMMA-RAY PRODUCTION DATA SETS FROM THE POPOP4 LIBRARY. Ford III, W. E.; Gillen, J. S. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 185p. Dep. NTIS.

The uranium nonfission capture, fission capture, and inelastic scattering data sets included in the POPOP4 library of neutron-induced secondary gamma-ray yield and cross-section data were "tested" for use in the preparation of ^{238}U secondary gamma-ray production cross sections (SGRPXS's). The data sets were "tested" over various neutron energy ranges by comparing calculated secondary gamma-ray pulse-height spectra with previously measured spectra resulting from the exposure of a 30-mil-thick, depleted uranium foil to bare, thermal, Cd-, ^{10}B-, (Cd-^{10}B)-, and (Cd-1.377^{10}B)-filtered neutron beams from the ORNL TSR-II reactor. ^{238}U nonfission capture data sets 928109, 928112, and 928113 and the total SGRPXS data set 928901 are adequate for use in shielding calculations when used over the neutron and gamma-ray energy ranges for which the data are defined. In the absence of suitable ^{238}U fission capture and inelastic scattering data sets, ^{235}U data sets 925801 and 925301 were found to be adequate for these reactions in the preparation of ^{238}U SGRPXS's. (auth)

24323 ENERGY DISTRIBUTIONS OF FRAGMENTS FROM FISSION OF ^{238}U INDUCED MY MONOENERGETIC NEUTRONS FROM 1.5 TO 18.2 MeV. Arena, N.; Lo Nigro, S.; Milone, C. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy. Centro Sicialiano di Fisica Nucleare e di Struttura della Materia, Catania, Italy). Lett. Nuovo Cim.; 3: No. 4, 147-50(22 Jan 1972).

The energy spectra of fragments from the fission of ^{238}U by monoenergetic neutrons of 1.5, 5.2, and 18.2 MeV were measured using a silicon surface barrier detector. Gaussian fits to the spectra show that the energy corresponding to the maximum yield of heavy fragments seems practically independent of incident neutron energy while the peak for light fragments decreases with increasing neutron energy. (J.W.R.)

24324 SOME CUMULATIVE MASS-YIELDS AND PROMPT NEUTRON YIELDS FOR SELECTED MASSES FROM 14.8 MeV NEUTRON INDUCED FISSION OF ^{238}U. Birgul, O.; Lyle, S. J.; Wellum, R. (Univ. of Kent, Canterbury, Eng.). Radiochim. Acta; 16: No. 2, 104-6(Nov 1971).

Cumulative mass yields falling mainly on the inner wings of the yield curve and prompt neutron yields associated with fragment pairs in the 14.8-MeV neutron fission of ^{238}U were measured. The results were compared with previous data. (J.W.R.)

24325 ANALYSIS OF $\bar{\nu}$ VALUES FROM AN ENERGY BALANCE IN NEUTRON-INDUCED FISSION OF ^{233}U AND ^{239}Pu AT ENERGIES BELOW 1.6 MeV. Kolosov, N. P.; Kuz'minov, B. D.; Sergachev, A. I.; Surin, V. M. At. Energ. (USSR); 32: No. 1, 83-4(Jan 1972). (In Russian).

A detailed analysis was made of the average number of neutrons per fission ($\bar{\nu}$) from ^{233}U and ^{239}Pu over the neutron energy range 0 to 1.6 MeV. A graph is included which shows $\bar{\nu}$ as a function of

E_n in MeV, and compared the experimental results of the authors with those of a previous worker. (K.S.W.)

24326 DELAYED NEUTRON PRECURSORS. IV. ^{87}Se, ^{88}Se, AND ^{89}Se; HALF-LIVES, NEUTRON EMISSION PROBABILITIES, AND FISSION YIELDS. Tomlinson, L.; Hurdus, M. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 33: No. 11, 3609-20(Nov 1971).

Delayed neutron emission from short-lived selenium isotopes, produced in ^{235}U thermal neutron fission, was studied. Selenium isotopes were separated from other fission products by means of a rapid radiochemical method based on isotopic exchange with H_2Se gas. The following data were obtained: ^{87}Se: half-life, 5.41 ± 0.10 sec; neutron emiss. prob. (%) 0.16 ± 0.03; cum. fis. yield (%) 0.66 ± 0.13; ^{88}Se: half-life, 1.53 ± 0.06 sec; neutron emiss. prob. (%); 0.75 ± 0.06 cum. fis. yield (%) 0.39 ± 0.05; and ^{89}Se: half-life, 0.41 ± 0.04 sec; neutron emiss. prob. (%) 5.0 ± 1.5 cum. fis. yield (%) 0.11 ± 0.04. ^{89}Se is a new nuclide, identified for the first time in this work. The neutron emission probabilities increase as the number of neutrons in the nucleus increases, in agreement with theoretical expectations. The cumulative fission yields are in good agreement with semi-theoretical values calculated from the expected charge distributions at these mass numbers. (auth)

24327 ^{238}U NEUTRON RESONANCE RADIATION WIDTHS. Maletski, Kh.; Pikel'ner, I. B.; Salamatin, I. M.; Sharapov, E. I. At. Energ. (USSR); 32: No. 1, 49-51(Jan 1972). (In Russian).

The radiative capture and transmission of neutrons were measured on the pulsed fast reactor IBR with the injector (linear accelerator) for ^{238}U with the resolution time being 6 ns/m. Radiation width values Γ_γ for 30 resonances and neutron widths $\overline{\Gamma}_n$ for 38 resonances were obtained. The average width $m\overline{\Gamma}_\gamma \approx 24$ MeV, and the divergences of separate radiation widths from the average one do not exceed the measurement error. (auth)

24328 NEUTRON TOTAL CROSS-SECTION FLUCTUATIONS OF ^{235}U IN THE keV RANGE. Boeckhoff, K. H.; Dufrasne, A.; Rohr, G.; Weigmann, H. (EURATOM, Geel, Belgium). J. Nucl. Energy; 26: No. 2, 91-7(Feb 1972).

Relative neutron total cross-sections of ^{235}U were measured in the neutron energy range between 10 and 100 keV with a time-of-flight resolution of 0.3 nsec/m. Strong structure is observed in the total cross section, which is at least partly in agreement with the structure observed recently in high resolution fission cross-section measurements, thus indicating that the latter is at least in part due to the entrance rather than the fission channel. A Monte Carlo simulation of the total cross section shows that its structure may be fully explained in terms of pure resonance parameter statistics. (auth) (UK)

24329 FISSION YIELD FROM FRESHLY PREPARED ^{241}Pu. James, G. D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 26: No. 2, 99-103(Feb 1972).

The fission yield from freshly prepared ^{241}Pu is compared, over the neutron energy range below 20 eV, with that from ^{241}Pu which is several years old. In this energy range the neutron resonance structure of the two yields is identical and a detailed comparison of the thermal fission yield with the yield at the 0.26 eV resonance shows no significant difference between the two samples of ^{241}Pu. This rules out the explanation of a 0.34 yr half-life observed in the decay rate of the reactivity of a sample of ^{241}Pu in terms of an isomer with a high thermal fission cross-section. (auth) (UK)

24330 FISSION CROSS SECTION FOR ^{249}Cf IN THE NEUTRON ENERGY INTERVAL 0.16 TO 1.6 MeV. Vorotnikov, P. E.; Gokhberg, B. M.; Dubrovina, S. M.; (and others) (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 15: No. 1, 34-5 (Jan 1972). (In Russian).

The results are presented of measurements of the cross section of the ^{249}Cf fission by neutrons with energy between 0.16 and 1.6 MeV. The cross section reveals a smooth dependence on the neutron energy and is approximately equal to 2.2 barns at the large part of the explored energy interval. The energy being decreased between 0.5 and 0.16 MeV an increase of the cross section up to 3.5 barns is observed. (auth)

24331 NEUTRON YIELD AND KINETIC ENERGY OF FRAGMENTS AT FISSION OF ^{249}Cf BY THERMAL NEUTRONS. Volodin, K. E.; Nesterov, V. G.; Nurpeisov, B.; (and others) (Inst. of Atomic Energy, Moscow. Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 15: No. 1, 29-32(Jan 1972). (In Russian).

The average number of instantaneous neutrons $\overline{\nu} = 4.06 \pm 0.04$ and mean kinetic energy of fragments $\overline{E}_K = 187.3 \pm 1.5$ MeV for the fission of ^{249}Cf by thermal neutrons are measured. The dependence of $\overline{\nu}$ and $\overline{E}_K$ on the nucleon abundance of the fissile nucleons is discussed. (auth)

24332 PROMPT NEUTRONS AND KINETIC ENERGY OF FRAGMENTS FROM SPONTANEOUS FISSION OF ^{244}Cm. Alkhazov, I. D.; Kovalenko, S. S.; Kostochkin, O. I.; (and others). Yadern. Fiz.; 15: No. 1, 22-8(Jan 1972). (In Russian).

Kinetic energies of fragments and the total number of prompt neutrons are measured in a fission event for spontaneous fission of ^{244}Cm. Contour diagrams are obtained for the distribution of average number $\overline{\nu}$ of prompt neutrons per a fission event for various modes of the fission marked by the total kinetic energy, E_k, and by the mass of one of the fragments, M, as well as distributions of numbers of the fission events in the same coordinates. Starting from these curves dependences of $\overline{\nu}$ on M and E_k are calculated as well as the dependence of the excitation energy spent for the neutron emission on M. The dependences are mainly analogous to those for the spontaneous fission of ^{252}Cf. The mean value of the fragment excitation energy per an emitted neutron is determined to be 7.2 MeV. Independence of the mass distributions on ν and shrinking of the E_k distributions at fixed R and ν are noted. (auth)

24333 FINE STRUCTURE IN NEUTRON SPECTRUM OF SPONTANEOUS FISSION OF ^{252}Cf. Averchenkov, V. Ya.; Nefedov, Yu. Ya.; Khilkov, Yu. V. Yadern. Fiz.; 14: No. 6, 1134-43 (Dec 1971). (In Russian).

The neutron spectrum of spontaneous fission of ^{252}Cf is measured by the time-of-flight method. Instant fission γ quanta were used as the start signals. In the measured time distributions groups of monoenergetic neutrons with the energies 0.76, 1.02, 1.27, 1.68, 2.1, 2.6, 3.3, 4.1 MeV and less reliable with the energy 2.84, 4.9, and 6.1 MeV were observed. The data obtained made it possible to use the fission γ rays as start signals when applying ^{252}Cf as a neutron source in the time-of-flight method and gave some additional information on the mechanism of formation of neutron "fine structure." (auth)

24334 ENERGY DEPENDENCE OF YIELDS AND KINETIC ENERGIES OF ^{235}U FISSION FRAGMENTS. D'yachenko, P. P.; Kuz'minov, B. D.; Kutsaeva, L. S.; Piksaikin, V. M. Yadern. Fiz.; 14: No. 6, 1129-33(Dec 1971). (In Russian).

Results are presented of the study of the energy and mass distributions of fragments in the ^{235}U fission by monoenergetic neutrons at 0.6 to 3 MeV with steps of 100 to 250 keV. The results obtained confirm the presence of previously found irregularities in the energy dependence of yields and kinetic energies of fragments in the neutron energy region $E_n < 2.0$ MeV. The effects observed are discussed in framework of existing models. (auth)

24335 RATIO OF NEUTRON CROSS SECTIONS OF RADIATIVE CAPTURE AND FISSION FOR ^{239}Pu IN THE ENERGY REGION BELOW ~50 keV. Bergman, A. A.; Stavisskii, Yu. Ya.; Chelnokov, V. B.; (and others). Yadern. Fiz.; 14: No. 6, 1123-8 (Dec 1971). (In Russian).

Results are given of the measurements of parameter $\alpha(E)$ (ratio of the neutron cross sections of radiative capture and fission). Spectrometer of the Pb moderation-time method was used. The main feature is that a sample and a detector are placed in isotropic neutron field which does not vary due to scattering of neutrons on nucleus of the sample and the matter of the detector. The energy dependence $\alpha(E)$ is normalized using the well thermalized neutron spectrum obtained in a graphite prism. (auth)

24336 STUDY OF 66-SEC ISOMERIC STATE OF ^{222}Ac. Eskola, Kari (Univ. of California, Berkeley). Phys. Rev., C; 5: No. 3, 942-7(Mar 1972).

An isomeric state of ^{222}Ac with a half-life of 66 ± 3 s was discovered in bombardments of lead with ^{18}O ions. The isomer decays by α-particle emission and has a complex spectrum with major α-particle groups at 6.46 (2%), 6.71 (8%), 6.75 (15%), 6.81 (27%), 6.84 (10%), 6.89 (15%), 6.97 (8%), and 7.00 MeV (15%). Evidence for the decay of the isomeric state both by isomeric transition (<10%) and by electron capture (~1%) is presented. The half-life of ^{218}Fr was measured to be 0.7 ± 0.6 ms. (4 figures, 1 table) (auth)

24337 FURTHER MEASUREMENTS OF GAMMA TRANSITIONS IN SPONTANEOUS-FISSION FRAGMENTS OF ^{252}Cf. Hopkins, F. F.; White, J. R.; Phillips, G. W.; Moore, C. Fred; Richard, Patrick (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 3, 1015-30(Mar 1972).

Gamma rays in the range from 150 to 1000 keV were observed following the spontaneous fission of ^{252}Cf with a 20-cm^3 Ge(Li) detector [full width at half maximum (FWHM) 3.5 keV at 356 keV] in coincidence with K x rays from the fission fragments, observed with a 0.14-cm^3 Ge(Li) detector (FWHM 350 eV at 31 keV). Twenty-one 1024-channel γ-ray spectra were accumulated and sorted by computer, corresponding to windows set on K x rays from Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Sb, Te, I, Xe, Cs, Ba, La, Ce, Pr, Nd, Pm, Sm, and Eu. In conjunction with previous work,

these data allowed both mass and charge assignments to be made for about 90 of the observed transitions. Relative yields for certain γ rays in self-gated spectra, those for which both x ray and γ ray originated from the same isotope, were measured and compared with predictions based on previous work. (18 figures, 3 tables) (auth)

24338 SUB-COULOMB TRANSFER REACTIONS ON ACTINIDE NUCLEI. Erskine, J. R. (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 3, 959-73(Mar 1972).

Surprisingly large discrepancies have been found between some measured and calculated cross sections for sub-Coulomb transfer reactions on several actinide nuclei. The calculated cross sections of strongly excited states with $J \geq 7/2$ are generally too small by a factor of 2 to 3, such as were observed in the reaction $^{182}W(d,p)^{183}W$. A few exceptions to the above rule are found for weakly excited states. In the present study, the use of very low bombarding energies results in an important simplification of the analysis in that the calculated cross sections then are insensitive to uncertainties in the optical-model parameters. The results suggest that the discrepancy in cross sections probably results from inadequate treatment of the asymptotic tail of the bound-state wave function rather than from neglect of inelastic scattering processes in the incoming and outgoing waves. (13 figures, 7 tables, 56 references). (auth)

Nuclear Theory

Refer also to abstracts 23635, 23845, 23941, 23953, 23969, 24274, 24300, and 24302.

24339 (CONF-700122–, pp 1-26) SOME NEW FEATURES IN THE MICROSCOPIC THEORY OF (^{3}He,t) REACTIONS. Schaeffer, R. (California Univ., Livermore. Lawrence Radiation Lab.). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

A microscopic model of the (^{3}He,t) charge exchange reaction requires a good description of the initial and final bound states and also a good description of the reaction mechanism. The case for which the microscopic structure of the target is well known and the attempt made to predict the cross section is discussed. The central DWBA, exchange effects, and the tensor interaction are examined in detail. (J.W.R.)

24340 (CONF-700122–, pp 39-53) ROLE OF TENSOR FORCE IN CHARGE-EXCHANGE SCATTERING. Rost, E.; Kunz, P. D. (Colorado Univ., Boulder). Jan 1970.

From Argonne (^{3}He,t) symposium; Chicago, Ill. (25 Jan 1970).

Spin-flip charge exchange reactions proceed with the transfer of one unit of spin angular momentum. A large tensor component is needed in the effective interaction to properly describe these reactions. The evidence leading to this result is reviewed. The effects of various prescriptions and parameterizations are discussed. Some preliminary nuclear structure analyses where spin-flip, charge-exchange transitions seem very promising are described. (J.W.R.)

24341 (JINR-P2-6195) INELASTIC INTERACTIONS OF HIGH-ENERGY HELIUM IONS WITH ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Zheregy, F. G.; Iljinov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research Dubna (USSR)). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The inelastic collisions of helium ions of the energy more than a few dozens of MeV per nucleon are calculated by means of the intranuclear cascade model followed by taking into account an evaporation (or fission) process of excited residual nucleus. The effect of decreasing of target-nucleus nucleon number as the intranuclear cascade develops is discussed. The approximate model, in which an incident α-particle is represented as four unbound nucleons, is considered separately. Results of calculations are in an agreement with experimental data available. (auth)

24342 (JINR-P4-6149) DIRECT FISSION OF HEAVY NUCLEI BY IONS. Kalinkin, B. N.; Permyakov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

A model is formulated for the process of nucleus fission in the heavy ion reactions. This model includes the fission channel of a compound nucleus, in accordance with the statistical theory, as well as new channel of a direct fission occurring without the stage of the compound nucleus production. (auth)

24343 (KFKI-71-56) REDUCTION OF THE PROBLEM OF REARRANGEMENT PROCESSES TO A PAIR OF TWO-PARTICLE PROBLEMS. Dolinszky, T. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1967]. 9p. Dep. NTIS (U. S. Sales Only).

The solution of the problem of scattering between complex nuclei can be reduced by Feshbach's method to the solution of an effective two-particle problem. An extension of Feshbach's procedure to the case of rearrangement processes is proposed. It is shown that the problem of rearrangement can be traced back to a pair of scattering processes in the input and the output channel, respectively. The inhomogeneous integral equation for the two-particle radial wave function in the output channel is set up and solved formally by taking into account the boundary conditions represented by the incident wave. (auth)

24344 (LA-tr-71-75(Rev.)) COMPUTER ANALYSIS OF GAMMA-RAY SPECTRA. Tominaga, Hiroshi. Translated for Los Alamos Scientific Lab., N. Mex., from Radioisotopes (Tokyo); 20: No. 2, 93-101(1971). 21p. Dep. NTIS.

The method of analysis of gamma spectra in which the isotope is compared with the already known isotope data is discussed from the viewpoint of applied gamma spectrometry with regard to the line spectrum. The peak data treatment is considered in which the analytical treatment procedures, comparison of partial areas, subtraction of the curve background, peak function fitting, the search for peaks, and applications of other mathematical procedures are covered. Also the response spectrum data treatment is discussed covering spectrum stripping and least squares fitting. (J.F.P.)

24345 PERMUTATION SYMMETRY OF IDENTICAL CLUSTER SYSTEMS. Grama, N. (Max-Planck Institut fuer Kernphysik, Heidelberg). Lett. Nuovo Cim.; 2: No. 18, 934-6(30 Oct 1971).

A method for studying the symmetry of systems of N nucleons grouped in n identical clusters of m nucleons each, subject to permutations of both clusters and nucleons is presented. The method is developed by introducing the wreath product group $S_m \otimes S_n$ in the chain of groups $S_{mn} \supset S_m$. The 7.66-MeV state in ^{12}C is treated to illustrate the method. (J.N.R.)

24346 $1/\gamma$ VELOCITY DEPENDENCE OF NUCLEON–NUCLEUS OPTICAL POTENTIALS. Humphreys, Russ (Louisiana State Univ., Baton Rouge). Nucl. Phys.; A182: No. 3, 580-92(1972).

The paper proposes that the isospin-independent part of the strong nuclear force is due to a two-component local potential: an attractive Lorentz-invariant scalar part and a repulsive four-vector part. Such a potential leads to energy dependence in the shape, volume integral, and rms radius of the real central optical potential of a nucleus. The volume integral diminishes linearly as $1/\gamma$ diminishes, γ being the Lorentz γ-factor of the incident nucleon; and the integral becomes repulsive above 200 MeV. The paper examines published results of empirical optical-model fits and shows that the trends in the data support the $1/\gamma$ dependence. An unorthodox fit by Elton at 180 MeV supports the model's apostrophe and predictions. (auth)

24347 RELATION BETWEEN THE DEUTERON AND NUCLEON OPTICAL POTENTIALS. Johnson, R. C.; Soper, P. J. R. (Univ. of Surrey, Guildford, Eng.). Nucl. Phys.; A182: No. 3, 619-24 (1972).

It is pointed out that in a generalization of the Watanabe model of the deuteron optical potential in which energy-independent, non-local nucleon optical potentials are averaged over the deuteron internal wave function, the resultant non-local deuteron potential is found to have a range of non-locality very close to one-half of the range of non-locality of the nucleon optical potential. This in turn implies that an equivalent energy-dependent, local deuteron optical potential may be obtained by averaging the local equivalent of the nucleon optical potential, evaluated at half of the incident deuteron kinetic energy, over the deuteron ground size. The relevance of these results to deuteron elastic scattering is discussed. (auth)

24348 SIZE AND SHAPE OF NEUTRON-EXCESS NUCLEI. Steshenko, A. I.; Filippov, G. F. (Inst. of Theoretical Physics, Kiev). Yadern. Fiz.; 14: No. 4, 715-23(Oct 1971). (In Russian).

Size and shape of neutron-excess light nuclei are calculated by means of the variational method with three-dimensional anisotropic oscillator one-particle wave functions. Position of the stability limit is also estimated. (auth)

24349 REMARKS ON THE PEREY–BUCK EFFECT. Van Dijk, W. (Mount Allison Univ., Sackville, New Brunswick); Kiang, D. Nucl. Phys.; A181: No. 1, 106-12(1972).

The Perey-Buck effect is studied by comparing wave functions of non-local potentials with those of phase-equivalent local potentials which are energy independent. It is found that the Perey-Buck effect is true only for a restricted class of non-local potentials. Not only is it necessary that the extension of the non-locality be small, but also that the non-local potential obey a stringent condition such as the separability in the sum and difference of the coordinates, as assumed by Perey and Buck and by Austern. (auth)

24350 LOW-ENERGY PARTICLE-RESONANCE SCATTERING AND THREE-PARTICLE RESONANCES. Aitchison, I. J. R.; Krupa, D. (Oxford Univ.). Nucl. Phys.; A182: No. 3, 449-67 (1972).

An effective two-particle approach to the three-particle problem is formulated by defining the particle-resonance scattering amplitude as a residue in the connected three-particle amplitude. The dynamics of particle-resonance scattering is studied by the N/D method. Only the elastic cut due to particle-resonance intermediate states is taken into account, and the input force is the Peierls mechanism. It is found that, depending on the two-particle resonance parameters, the denominator function of the particle-resonance amplitude can have a pole near the physical region, and an associated zero which, being a pole of the amplitude, is interpreted as a three-particle resonance. A possible application of this to a level in ^{12}C, viewed as a $^{8}Be + \alpha$ system, is suggested. (auth)

24351 FERMIONIC REALIZATION OF DYNAMICAL GROUPS IN NUCLEI. Afanas'ev, G. N.; Mikhailov, I. N.; Raichev, P. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 4, 734-43(Oct 1971). (In Russian).

It is discussed which operator algebras can be constructed from fermionic operators and under which conditions the constructed algebras relate to dynamical nuclear processes. The symplectic group Sp(3,3) appears to be the dynamical symmetry group describing the transition of vibrational multiplets SU(3) into infinite rotational ones. It is shown that the operators of electric quadrupole transitions are contained both in the semi-simple algebra Sp(3,3) and inhomogenous non-semisimple algebras. (auth)

24352 YIELD CORRELATIONS FOR (n,γ) AND (d,p) REACTIONS WITH LIGHT NUCLEI. Belousova, V. I.; Rudak, E. A.; Khil'manovich, A. M. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 125-6(1971). (In Russian).

Yield correlations were compared for nuclear reactions of (n,γ) and (d,p) types in connection with nuclei where A < 45. Pertinent calculations were made using a Saxon–Woods type potential. (tr-auth)

24353 THEORY OF SPONTANEOUS ALPHA DISINTEGRATION. Bhattacharyya, A. K. (Inst. of Theoretical Physics, Calcutta). Indian J. Theor. Phys.; 19: No. 2, 41-56(Jun 1971).

The problem of spontaneous alpha emission from natural radioactive nuclei is discussed in connection with the idea of (i) existence of a short range extranuclear force between the emitted alpha particle and the daughter nucleus, (ii) phase fluid damping inside the nucleus causing alpha emission. The W.K.B. approximation has been adopted for solving the wave equations. The disintegration constant determined with the above assumptions is very simply related with charge and mass of the daughter nucleus and energy of the alpha particle. Satisfactory agreement has been obtained with the experimental results. (auth)

24354 ANGULAR-CORRELATION FORMALISM INVOLVING SEPARATED NUCLEAR HYPERFINE TRANSITIONS. Bueche, G.; Appel, H. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Phys.; 250: No. 2, 145-54(1972).

γ–γ-angular correlation functions are presented for cases where the splitting energy of the nuclear substates, ΔE, is large compared with the level width Γ. The functions are particularly applicable to correlation work, where separated hyperfine transitions are involved. Usually, they will be observed by Moessbauer techniques. Another field of application arises from application of low temperatures to long lived isomers or from reactions initiated by polarized particles. In general, these correlations exhibit large anisotropies. Also those correlations are accessible for which the usual correlation coefficients $F_k(LL'JJ')$ are zero. (auth)

24355 PAIRING ROTATIONS AND SEPARATION ENERGIES. Beck, Rainer; Kleber, Manfred; Schmidt, Hartwig (Technische Univ., Munich. Teilinstitut Theorie, Munich). Z. Phys.; 250: No. 2, 155-65(1972).

Recent experiments exhibit a strong regularity of the two-neutron (proton) binding energies in superconducting nuclei. Using BCS calculations by Soloviev and by Kisslinger and Sorensen for the rare earth and tin region, respectively, it is shown that the pairing rotational model accounts for this behavior provided the deformation does not change appreciably when two neutrons or protons are added to the system. The model relates the degree of pairing to the ground state energies of neighboring even–even nuclei and supplements the information coming from the odd–even effect. (auth)

24356 NUCLEAR MAGNETIC MOMENT. Yamazaki, Toshimitsu (Tokyo Univ.). Nippon Butsuri Gakkaishi; 26: No. 9, 637-52(Sep 1971). (In Japanese).

The present status of research on nuclear magnetic moments is reviewed, especially concerning moments of excited states. The nuclear magnetic moment is a good probe for the electromagnetic field outside nuclei, and has been used for study of solid state physics. The moment is also a good probe for nuclear structure, and has meaning in elementary particle physics. Measurement of the nuclear magnetic moment is carried out by measuring Zeeman energy splitting or Larmor frequency. Practical methods to measure the moment in excited states of nuclei are measurement of time differential perturbed angular distribution of nuclear radiation, stroboscopic resonance method, nuclear magnetic resonance (NMR) of recoil nuclei, measurement of the perturbed angular distribution of NMR, and the NMR method of polarized nuclei. The anomalous magnetic moment of nucleons is explained by meson theory. A model to explain the moment of nuclei was presented by Schmidt, and has been known as the Schmidt model. Experimental values, however, showed small deviation from calculated values by the Schmidt model. The quenching theory of meson exchange effect was developed to explain the deviation. Another theory, the so-called configuration mixing theory, was also presented, and was more successful for explanation of the experimental values. However, there remains one discrepancy between the theoretical and the experimental results. Results of a recent experiment showed that the quenching theory is important as well as the configuration mixing theory. Other topics discussed concerning the nuclear magnetic moment are moments of odd nuclei, moments of mirror nuclei and moments in collectively excited state of nuclei. (Japan)

24357 DEPENDENCE OF THE ELECTRO-EXCITATION CROSS SECTION OF SOME LIGHT NUCLEI ON CHOICE OF THE SCHEME OF COUPLING. Tartakovskii, V. K.; Fursaev, A. V. (Kiev State Univ.). Yadern. Fiz.; 15: No. 1, 51-4(Jan 1972). (In Russian).

A dependence of the electro-excitation cross section of a number of low-lying nuclear levels on the scheme of coupling is considered for 1p-shell closed light nuclei. When transforming from ls-coupling to intermediate one the angular distributions are changed only in magnitude for C2, E2 and M3 transitions and are also changed in shape for M1 transition. In some cases the electron angular distribution is shown to be very sensitive to small variations of the nuclear coupling scheme. (auth)

24358 HYDRODYNAMICAL LIMIT FOR FINITE FERMI-SYSTEMS. Rumyantsev, B. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 15: No. 1, 46-50(Jan 1972). (In Russian).

Hydrodynamical equations for the phase of the pairing parameter $\Delta(r) = |\Delta|e^{i\varphi}$ are deduced in framework of superfluid nuclear model. The equations are valid in the region $|\Delta| \gg \epsilon_F A^{-\frac{1}{3}}$, $\partial\varphi/\partial r \ll 1/\xi$ (ξ – is correlation length). The contribution of the pairing interaction to the surface energy of the nucleus is calculated within hydrodynamical limit. (auth)

24359 ACCURACY OF THE K-HARMONIC METHOD. Pavlichenkov, I. M. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 15: No. 1, 39-45(Jan 1972). (In Russian).

Exact solutions of the one-dimensional Schrödinger equation for a particle system with a pair δ-like interaction and for a system of particles in a δ-like potential well are compared with the zero approximation of the K-harmonic method. The K-harmonic method is shown to lead to better results for a system with large particle density. The estimation obtained is a lower limit of the K-harmonic method precision as the wave functions in the problems being considered are completely symmetric relative to particles permutation. (auth)

24360 YIELD-FUNCTION ANALYSIS FOR PHOTONUCLEAR REACTION CROSS SECTIONS. Baciu, G. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: No. 4, 421-35(1970). (In Rumanian).

After a general introduction, the concept of the photonuclear yield function is discussed, and an expression for the photonuclear reaction cross section is derived. The interpretation of the results is explained. (5 figures) (R.W.R.)

24361 THEORETICAL ASPECTS OF QUADRUPOLE PERTURBATIONS OF TIME-INTEGRATED ANGULAR CORRELATIONS. Alonso, Carol Travis; Grodzins, Lee (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., C; 5: No. 3, 728-38 (Mar 1972).

Computations were made in order to determine the optimum geometries for time-integrated angular-correlation experiments perturbed by static axially symmetric electric field gradients. Several new properties of the interaction are discussed, including planes of negative attenuation (enhancement), cases for which no interaction is allowed to occur, and new aspects of the concept of hard-core angular correlations. (16 figures, 1 table) (auth)

24362 ONE-PARTICLE RESONANCES IN NUCLEON–NUCLEI REACTION AND ELASTIC SCATTERING CROSS SECTIONS. Zaretskii, D. F.; Sirotkin, V. K.; Urin, M. G. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 14: No. 6, 1179-90(Dec 1971). (In Russian).

Formation of one-particle resonances in reaction and elastic scattering cross sections is considered by means of the approach based on the explicit introduction of the compound-nucleus states in the nucleon-nuclei scattering problem. The obtained expressions for the sticking coefficients have an asymmetry in the energy dependence in contrast to predictions of the optical model. A method for practical calculations of the cross sections is presented. The method is applied to the calculation of the under-barrier (p,n)-reaction cross section in the region of the one-particle s resonance. (auth)

24363 COEFFICIENTS OF THE PAIR CONVERSION FOR E1 AND M1 MULTIPOLARITIES AT HIGH ENERGY TRANSITIONS (UP TO 10 MeV). Belyaev, B. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 6, 1151-7(Dec 1971). (In Russian).

The role of the electron-positron pair production in experimental determination of spins and parities of nuclear excitation high-energy levels (up to 10 MeV) is elucidated. The pair conversion coefficients (PCC, α_π) were calculated with the wave functions of the electron and positron being the solutions of the Dirac equation with the Coulomb potential $\alpha Z/r$. The effects of nuclear dimensions, screening and radiative corrections are neglected. The calculations show a considerable deviation of the pair conversion differential coefficients (PCDC, $d\alpha_\pi/dE_+$) and of the PCC from the Born approximations. Strong dependence of the PCC-M1-transition on Z is noted. A conclusion is made on the sensitivity of PCC measurement method and especially of α_π/α_k for obtaining the quantum characteristics of high nuclear excitation levels in rather wide region of Z and k. (auth)

24364 RESONANCE SCATTERING ON DEFORMED NUCLEI AND COUPLED-CHANNEL APPROACH. Dumitrescu, Ovidiu (Ruhr Univ., Bochum, Ger.); Cioaca, Constantin. Rev. Roum. Phys.; 16: No. 10, 1125-7(1971).

The coupled-channels approach is used to investigate resonance scattering by deformed nuclei. Expressions for appropriate Hamiltonians are obtained, and the compound state is constructed as a resonance function: the bound character of all motions is retained except for the projectile–target motion, which must be solved separately. One-nucleon scattering can be solved fairly easily; use of Moshinsky algebra permits realistic solutions for composite projectiles also. (R.W.R.)

24365 WIDTHS OF ONE-PARTICLE QUASISTATIONARY STATES. Kadmenskii, S. G.; Kalechits, V. E.; Martynov, A. A. (Voronezh State Univ., USSR). Yadern. Fiz.; 14: No. 6, 1174-8(Dec 1971). (In Russian).

A formula is constructed for the width of one-particle quasistationary state determined by the overlapping integral of quasistationary wave function, internal potential and wave function of the final channel. The formula obtained is generalized to the case of arbitrary redistribution of potentials. The widths of the shell quasistationary states of spherical nuclei number are calculated. (auth)

24366 PION PHOTOPRODUCTION ON NUCLEI WITH NUCLEON EMISSION. Shebenko, A. V. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 6, 1191-8(Dec 1971). (In Russian).

The approach is considered which may be an initial point for calculations of angular distributions and energy spectra for various nucleon associations observed in reactions of pion photoproduction on nuclei. The main attention is drawn to the rigorous statement of the problem of calculating the summary probability of transitions from an initial state into an infinite set of particular channel states not producing the complete system. A way of eliminating difficulties encountered with the latter circumstance is shown reformulating the theory in terms of states satisfying the completeness condition. Using this condition in various approximations, the expressions are obtained for cross sections of nucleon and deuteron emission in photoproduction of pions on nuclei. (auth)

24367 EFFECTIVE SCREENING PARAMETERS IN THE THEORY OF INTERNAL CONVERSION IN THE M-SHELL OF THE ATOM. Borisoglebskii, L. A.; Levshinova, A. S.; Trusov, V. F. (Belorussian State Univ., Minsk). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 103-9(1971). (In Russian).

The dependence of the effective screening parameters $\sigma(\sigma = Z - Z_{eff})$ on Z, the multipole order, parity, and energy of nuclear transition was investigated. This study was based on the theory of internal conversion in the M shell, with account taken of screening in the Thomas–Fermi–Dirac and Gaspar (Gashpar?) concepts with semi-empirical corrections. (2 figures, 6 tables) (tr-auth)

24368 FISSION BARRIERS AND THE INCLUSION OF AXIAL ASYMMETRY. Larsson, S. E.; Ragnarsson, I.; Nilsson, S. G. (Inst. of Tech., Lund, Sweden). Phys. Lett.; 38B: No. 5, 269-73 (6 Mar 1972).

The nuclear potential-energy surface was calculated on the basis of the modified-oscillator model with the inclusion of the degrees of freedom of axial asymmetry. For the heavier actinides the inner barrier is found to be reduced by up to one MeV. This is in agreement with the results obtained by Pashkevich [Nucl. Phys., A133, 400(1969)]. For superheavy elements a similar reduction is obtained. (auth)

24369 EVIDENCE FOR THE EXISTENCE OF HIGHLY EXCITED BANDS OF INTERMEDIATE RESONANCES DESCRIBING QUASI-MOLECULAR ROTATIONS. Rinat, A. S. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett.; 38B: No. 5, 281-5(6 Mar 1972).

Anomalously large, oscillating backward-angle differential cross sections for scattering of α's on, in particular, α-particle nuclei are analyzed. It is argued that the observed structures may correspond to intermediate resonances describing quasi-molecular rotations. Further evidence is obtained from selected inelastic α scatterings and from reactions involving α-particle clusters. (auth)

24370 THREE-PARAMETER DESCRIPTION OF THE NUCLEAR SHAPE IN FISSION. Schultheis, H.; Schultheis, R. (Univ., Munich). Lett. Nuovo Cim.; 3: No. 8, 313-16(19 Feb 1972).

A variant of the parametrization of Hass, Ebert, and Suessman [Nucl. Phys., A106, 117 (1968)] for mass asymmetry in fission is presented which can describe the necking-in of the nucleus in a more convenient way. A parameter with a precise geometrical meaning is introduced. Among the advantages of this parameter are the following: the constriction parameter grows with increasing constriction; the limits of 0 and 1 are finite and permit an easier understanding of intermediate values; the nuclear length is coupled to the necking-in. The liquid-drop energy of ^{236}U calculated in this parametrization is shown. (2 figures) (R.W.R.)

24371 COULOMB CORRECTION IN NUCLEAR β DECAY: ELEMENTARY-PARTICLE TREATMENT. Armstrong, Lloyd Jr.; Kim, C. W. (Johns Hopkins Univ., Baltimore). Phys. Rev., C; 5: No. 3, 672-81(Mar 1972).

The "elementary-particle" treatment of nuclear β decay is extended to include the effects of final-state Coulomb interactions. The resulting formalism is valid for both allowed and forbidden decays. The Coulomb correction in allowed transitions is considered in detail and compared with the usual impulse-approximation calculation. The spectrum shape factor for the transition $B^{12} \rightarrow C^{12} + e^- + \bar{\nu}_e$ is evaluated as an example. (auth)

24372 VALIDITY OF STRUTINSKY'S THEORY OF RENORMALIZATION. Krieger, S. J. (Univ. of Illinois, Chicago. Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 28: No. 11, 690-3(13 Mar 1972).

The validity of Strutinsky's theory of renormalization is examined by comparing its predictions with those of a Hartree–Fock (HF) calculation for the nucleus ^{32}S. Very good agreement is obtained if the single-particle states from the HF calculation are used in the Strutinsky calculation. For a conventional Strutinsky calculation using a phenomenological Nilsson potential, agreement with HF results is not so good. The latter agreement is improved if one treats the quadrupole moment of the density rather than that of the average potential as the independent variable. (auth)

24373 NEW CALCULATION OF FISSION BARRIERS FOR HEAVY AND SUPERHEAVY NUCLEI. Bolsterli, M.; Fiset, E. O.; Nix, J. R.; Norton, J. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 3, 1050-77(Mar 1972).

On the basis of the macroscopic–microscopic method a calculation of the nuclear potential energy of deformation for heavy and superheavy nuclei was performed. The primary emphasis was to develop techniques that permit more accurate extrapolations, both to the large deformations encountered in fission and heavy-ion reactions and to new regions of nuclei. With this purpose in mind, the nuclear shape is specified with five degrees of freedom, in terms of smoothly joined portions of three quadratic surfaces of revolution (e.g., two spheroids connected by a hyperboloidal neck). The single-particle potential is obtained by folding a Yukawa function with a uniform sharp-surface generating potential of appropriate shape. The parameters describing the potential are obtained from statistical (Thomas–Fermi) calculations that reproduce correctly the average trends throughout the Periodic Table

of a variety of nuclear properties. The method used to solve the Schroedinger equation for the single-particle energies and wave functions was mainly an expansion of the wave function in a set of deformed harmonic-oscillator basis functions, but a finite-difference method was also investigated. Shell and pairing corrections are calculated from the single-particle energies by means of the methods developed by Strutinsky and added to the surface and Coulomb energies of the liquid-drop model to obtain the total potential energy of deformation. This approach is found to reproduce reasonably well the over-all trends of experimental fission-barrier heights of nuclei ranging from rare earths to actinides. The calculated fission barriers of actinide nuclei contain two peaks separated by a secondary minimum. The over-all variation in the relative heights of the two peaks agrees with experimental results, but the calculated first peak is somewhat low for thorium isotopes and somewhat high for curium isotopes. For the actinides the first saddle point is found to be symmetric in shape; and the second saddle point, asymmetric. The highest saddle point is asymmetric for ^{226}Ra and ^{210}Po and symmetric for ^{188}Os. The fission barriers of superheavy nuclei near ^{298}114 are even higher than previously supposed. With respect to spontaneous fission, the island of superheavy nuclei is a mountain ridge extending from 114 protons to about 124 protons. The descent from the mountain down to the sea of instability is rather gentle for decreasing neutron numbers below 184, but is more rapid on the other three sides. (22 figures, 1 table, 159 references) (auth)

24374 PREDOMINANCE OF PROTON STRIPPING OVER PROTON PICKUP IN HEAVY-ION REACTIONS. Abul-Magd, A. Y. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., C; 5: No. 3, 599-602(Mar 1972).

The statistical theory of nuclear reactions is applied to explain the strong tendency for protons to be transferred out of the projectile when heavy targets are bombarded by moderately heavy projectiles. The predictions of the theory for the relative probability of stripping to pickup reactions agree in general with the experimental data, and the degree of agreement increases with increasing number of transferred nucleons. (1 table) (auth)

24375 TENSOR CORRELATIONS IN NUCLEAR MATTER: THREE-BODY EFFECTS. Ristig, M. L. (Univ., Cologne); Ter Louw, W. J.; Clark, J. W. Phys. Rev., C; 5: No. 3, 695-706(Mar 1972).

The Jastrow method has been extended to the treatment of tensor forces by the incorporation of suitable spin and isospin dependence into the correlation operators. Here, the three-body contributions to the factor-cluster expansion of the energy expectation value are evaluated for nuclear matter, this evaluation supplementing the evaluation of the one- and two-body contributions already reported in the first paper of this series. Complete numerical results are presented for three semirealistic hard-core potentials containing differing mixtures of central and tensor components. The three-body corrections result in a distinct improvement of the saturation behavior of the approximate energy per particle. Nevertheless, these calculations should be regarded as still exploratory rather than final in the sense that the most intelligent (i.e., a suitably restricted) choice of radial dependence has not yet been determined for the correlation functions. (3 figures) (auth)

24376 EXPANSION OF THE TWO-NUCLEON T MATRIX HALF OFF THE ENERGY SHELL. Redish, Edward F.; Stephenson, G. J. Jr.; Picker, H. S. (Univ. of Maryland, College Park). Phys. Rev., C; 5: No. 3, 707-18(Mar 1972).

Current descriptions of (p,2p) reactions, nucleon–nucleon bremsstrahlung, and low-energy pion production use the half-off-shell two-nucleon T matrix in the neighborhood of the on-shell point. A method for expanding the amplitude $t_0(p,k,;k^2)$ in powers of $p - k$ is presented. After explicit extraction of the contributions arising from the long-range part of the interaction, a power series with an infinite radius of convergence is obtained. The coefficients of this series are expressed in terms of weighted integrals of the difference function, this procedure permitting a determination of precisely how variations of the interior wave function affect the near off-shell behavior of the half-shell T matrix. This allows treatment of a large class of models for the two-nucleon interaction, including wave-function models, as well as local, nonlocal, and energy-dependent potentials. As an example, this method is applied to a wave-function model of the two-nucleon $^1S_0$ T matrix constructed in a previous paper. It is found that the expansion converges rapidly and that the inclusion of more terms extends the representation farther off the energy shell. The expansion coefficients are smooth, rapidly decreasing functions of energy. The even coefficients and the odd coefficients each form a family of similar functions, which fall off rapidly with index. The T matrix arising from this model is very similar to those T matrices obtained with realistic potentials. Since the coefficient functions can be tabulated or parametrized quite simply, this expansion should provide a compact, useful method of expressing and comparing the near off-shell behavior of the two-nucleon half-shell T matrices arising from different models while permitting one to maintain both a fixed phase shift and the correct long-range behavior of the potential. (7 figures, 1 table) (auth)

24377 PROBLEMS WITH PERTURBATION TREATMENTS OF ANHARMONIC NUCLEAR OSCILLATIONS. Marshalek, E. R.; Sabato, M. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 5: No. 3, 1130-4(Mar 1972).

Microscopic expressions are obtained for the coefficients in the angular momentum expansion $E_I = a_2(\frac{1}{2}\mathfrak{D} + a_4(\frac{1}{2}\mathfrak{D})^2 + \cdots$ of the energies of quasi-rotational members of quadrupole vibrational bands. Some limitations on the applicability of perturbation treatments of anharmonic corrections to the random-phase approximation are noted. (auth)

24378 NUCLEAR-MATTER CALCULATIONS USING A REALISTIC NUCLEON–NUCLEON POTENTIAL. Bhattacharyya, S. (Shibpur Dinabundhoo Coll., India); Roy, M. K. Phys. Rev., C; 5: No. 3, 911-13(Mar 1972).

A realistic nucleon–nucleon potential is used to formulate a simple Thomas–Fermi method for nuclear-structure calculations. The potential-energy density has only one free parameter, which is found by fitting with Bhargava and Sprung's calculation [Ann. Phys. (N.Y.), 42, 222(1967)]. The short-range repulsion is absorbed in the term containing the free parameter. The compressibility comes out to be good. The method is illustrated in nuclear matter only with ^1S and ^3S states, although the method is applicable in the general case. (2 tables) (auth)

24379 VARIATION IN NUCLEAR-MATTER BINDING ENERGIES WITH PHASE-SHIFT-EQUIVALENT TWO-BODY POTENTIALS. Coester, F.; Day, B.; Goodman, A. (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 3, 1135-6(Mar 1972).

Three-body-correlation corrections to the saturation curves of two phase-shift-equivalent potentials were computed. The corrections for both curves are of the same sign. They are very small at normal densities but increase rapidly with increasing density and defect integral. (1 figure) (auth)

24380 SHELL EFFECTS ON NUCLEAR LEVEL DENSITIES. Ramamurthy, V. S.; Kataria, S. K.; Kapoor, S. S. (Bhabha Atomic Research Centre, Trombay, India). Phys. Rev., C; 5: No. 3, 1121-6(Mar 1972).

Numerical evaluation of the entropy of a system of fermions moving in a model single-particle level scheme was carried out, and the results were compared with the analytical expression derived by Kahn and Rosenzweig. It is shown that, in the asymptotic high-energy limit, the total additive correction to the excitation energy, and not merely a part of it, is equal to the ground-state shell correction. (2 figures) (auth)

24381 CONSEQUENCES OF ISOSPIN SUM RULES FOR PHOTONUCLEAR REACTIONS. Hayward, Evans; Gibson, B. F.; O'Connell, J. S. (National Bureau of Standards, Washington, D. C.). Phys. Rev., C; 5: No. 3, 846-52(Mar 1972).

Isospin sum rules for photonuclear reactions are derived; they relate the strengths of the two isospin components of the giant resonance to the isoscalar, isovector, and isotensor radii of the nucleus. The connection between these radii and both the number and correlations of excess neutrons is discussed. A semiempirical formula for the fraction of the dipole strength in the T + 1 giant resonance is derived, and various experimental data are discussed in the light of the results obtained by using this equation. (1 figure, 1 table, 48 references) (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

24382 (CONF-720401-2) FUSION POWER: AN ALTERNATIVE ENERGY SOURCE. Postma, Herman (Oak Ridge National Lab., Tenn.). [1971]. 5p. Dep. NTIS.

From Region III conference on scanning the spectrum; Knoxville, Tenn. (10 Apr 1972).

Controlled power from the fusion process does not now exist but its present status as well as its goals, approaches directed toward proving that fusion can eventually be an alternative energy source, are described. The means to scientific proof are pointed out and the series of likely engineering problems that must be solved for fusion power to become economically attractive are described. With the presently cloudy perception, such a realization of fusion power will take thirty years and cost two to four billion dollars. (auth)

24383 (STI/PUB-288(Vol.1)) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH 1971. VOL. I. Proceedings Series. Proceedings of the Fourth International Conference Held at Madison, Wisconsin, 17–23 June 1971. (International Atomic Energy Agency, Vienna (Austria)). Oct 1971. 700p. (In several languages). (CONF-710607-(Vol.1)). IAEA $20.00.

Forty-nine papers are included. They are divided under the 4 sessions: (1) internal ring devices, (2) pinches; stabilization methods, (3) tokamaks, and (4) plasma focus; laser- and electron-beam-produced plasmas. For abstracts of individual papers see NSA Vol. 25, No. 16. (M.O.W.)

24384 (STI/PUB-288(Vol.2)) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH 1971. VOL. II. Proceedings Series. Proceedings of the Fourth International Conference Held at Madison, Wisconsin, 17–23 June 1971. (International Atomic Energy Agency, Vienna (Austria)). Nov 1971. 766p. (In several languages). (CONF-710607-(Vol.2)). IAEA $20.00.

Fifty-one papers are included. They are arranged according to the following three areas: (1) turbulence, (2) tokamaks, and (3) open confinement systems. For abstracts of individual papers see NSA Vol. 25, No. 16. (M.O.W.)

24385 (STI/PUB-288(Vol.3)) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH 1971. VOL. III. Proceedings Series. Proceedings of the Fourth International Conference Held at Madison, Wisconsin, 17–23 June 1971. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 683p. (In several languages). (CONF-710607-(Vol.3)). IAEA $20.00.

Forty-four papers are included. They are arranged according to the following topics: (1) closed confinement systems, (2) theta pinches; shock waves, (3) reactor systems, and (4) high-frequency heating. For abstracts of individual papers see NSA Vol. 25, No. 16. (M.O.W.)

24386 FOURTH EUROPEAN CONFERENCE ON CONTROLLED FUSION AND PLASMA PHYSICS, ROME, ITALY, AUGUST 31–SEPTEMBER 4, 1970. Rome; Comitato Nazionale per l'Energia Nucleare (1970). 197p. Lit. 2,500. (CONF-700817).

Separate abstracts were prepared for 154 of the papers; 5 abstracts of papers were not abstracted. The remaining 26 papers appeared previously in NSA; for abstracts of these papers see CONF-700817 in the NSA cumulative Report Number Index. (M.O.W.)

For abstracts of individual papers see: 24391–24435, 24442–24450, 24455–24456, 24458–24470, 24476–24481, 24497–24502, 24511–24534, 24553–24565, and 24576–24611.

24387 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, NO. 1, 1972. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 53p.

This listing contains 263 references on various aspects of the subject. (M.O.W.)

24388 PLASMA PHYSICS INDEX. VOLUME 7, NO. 1, 1972. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 144p.

This listing contains 457 references on various aspects of the subject. (M.O.W.)

Confinement and Heating

Refer also to abstracts 23880, 24510, and 24576.

24389 (COO-3165-1) FUNDAMENTAL STUDIES OF TURBULENT HEATING OF A PLASMA. Annual Progress Report, 1 April 1971–31 March 1972. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). Contract AT(30-1)-3958. 22p. Dep. NTIS.

During the past year concentration has been on scaling laws and on optimizing the experiment as a plasma-heating device. Outstanding among results are the measurements of ion energy distribution and isotropy, made with three different analyzers, all having dual channels. Microwave scattering has provided information on the spectrum of turbulence, from which new details of turbulent heating were learned. The addition of far-infrared scattering during the coming year will extend the frequency and wave number spectra. Some interesting features of turbulent heating related to the spectrum of turbulence include anomalous resistivity, plasma transport, and the ion energy distribution. These features are also measurable independently in the experiment. Magnetic probes, a conductivity probe, a voltage-divider probe, and Rogowski loops are used to obtain the resistance. A Faraday cup and the conductivity probe determine the radial distribution as a function of time. A diamagnetic loop and an energy analyzer for charge-exchange neutrals determine the plasma heating and ion energy distribution as a function of time. (M.O.W.)

24390 (EUR-CEA-FC-621) NON-LINEAR THEORY OF TRANSIT TIME MAGNETIC PUMPING IN TOROIDAL GEOMETRY. Canobbio, E. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1971. 9p. (CONF-711016-9). Dep. NTIS (U. S. Sales Only).

From Conference on plasma theory; Kiev, USSR (19 Oct 1971).

An exact method for deriving the power absorbed by T.T.M.P. (Transit Time Magnetic Pumping) is outlined for the low ν region, ν being the Coulomb scattering time. The variational method used was recently introduced by Rosenbluth to derive the diffusion coefficients in the banana region, from the full Fokker–Planck collision operator. (France)

24391 EFFECT OF LONGITUDINAL ELECTRIC FIELD ON TOROIDAL DIFFUSION. Rutherford, P.; Kovrizhnikh, L.; Rosenbluth, M. (International Centre for Theoretical Physics, Trieste, Italy). pp 2 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The driving toroidal electric field in tokamaks is shown to lead to a significant pinching effect. For $\beta_\theta < 1$ this pinching is more rapid than outward diffusion in the banana and plateau regimes. (auth)

24392 CLASSICAL DIFFUSION IN TOKAMAKS. Feneberg, W. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). pp 3 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The mass flow perpendicular to the magnetic surfaces is calculated for rotational symmetric systems. The influence of an induced electric field on the classical diffusion is included. The formula will be simplified for a special self-consistent tokamak case with magnetic surfaces of nearly circular cross sections. It is shown that a stationary equilibrium with vanishing mass flow has no physical meaning for realistic tokamak conditions. (auth)

24393 PLASMA EQUILIBRIA OF TOKAMAK TYPE. Zehrfeld, H. B.; Green, B. J. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). pp 4 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A general formalism for description of an axisymmetric plasma equilibrium is given. This is a model for the steady operation of a tokamak device. Hydromagnetic equations taking into account effects such as tensorial resistivity and finite thermal conductivity are used. The reformulation of this set leads to an equivalent set, including the generalization to toroidal geometry of the Bennett–

Pinch relation, and an expression for the resistive plasma loss which shows explicitly the effect of the discharge current. This mathematically concise presentation of the full resistive equilibrium problem is appropriate for practical calculations. (auth)

24394 PLASMA DIFFUSION IN TOROIDAL SYSTEMS WITH ANISOTROPIC PRESSURE. Dobrowolny, M.; Pogutse, O. (International Centre for Theoretical Physics, Trieste, Italy). pp 5 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The problem of resistive diffusion of a plasma with anisotropic pressure in a toroidal system is considered. The diffusion decreases, with respect to the isotropic pressure case, when $p_\parallel > p_\perp$ and increases in the opposite case. (auth)

24395 CLASSICAL DIFFUSION OF PLASMA IN TOROIDAL SYSTEMS. Pogutse, O. (International Centre for Theoretical Physics, Trieste, Italy). pp 7 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The problems of resistive diffusion, and thermal conductivity of a rotating toroidal plasma are considered. It is shown that the coefficient of thermal conductivity is strongly decreased in the case of sufficiently large collision frequency. A large transverse electric field is presented in the plasma and its direction depends on the collision frequency. (auth)

24396 CLASSICAL DIFFUSION IN AN AXISMMETRIC TOROIDAL PLASMA FOR ARBITRARY COLLISION FREQUENCIES. Connor, J. W.; Stringer, T. E. (Culham Lab., Abingdon, Eng.). pp 8 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Expressions are obtained for classical diffusion in an axisymmetric torus, valid over a wide range of conditions which includes the intermediate and highly collisional regimes. Various limiting cases are considered and the ambipolar condition is discussed. (auth)

24397 BULK VISCOSITY, MAGNETIC-FIELD CORRUGATIONS, AND CONTAINMENT IN TOROIDAL CONFIGURATIONS. Dawson, J. M.; Winsor, N. K.; Bowers, E. C.; Johnson, J. L. (Princeton Univ., N. J.). pp 9 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The dissipation associated with hydrodynamic flow through magnetic field corrugations reduces the ability of a plasma to compensate for E × B, gradient B, and other drifts by flow parallel to B. This effect is investigated for toroidal confinement. (auth)

24398 ROTATION AND DIFFUSION IN A SELF-CONSISTENT TOROIDAL PLASMA. Haines, M. G. (Imperial Coll. of Science and Tech., London). pp 10 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An axisymmetric resistive toroidal plasma is considered in the tokamak configuration in which plasma currents produce the rotational transform necessary for containment. The self-consistent magnetic field resulting from all plasma currents is included in this fluid model, and the rotations and diffusion are found as functions of time. Several effects, additional to the Pfirsch–Schluter correction, and comparable in magnitude, contribute to the diffusion, in particular one term depending on the shear and another on the outward displacement of the plasma relative to the magnetic axis. (auth)

24399 EFFECT OF INERTIA ON LOSSES FROM A PLASMA IN TOROIDAL EQUILIBRIUM. Green, B. J.; Zehrfeld, H. P.; (Institut fuer Plasmaphysik GmbH, Garching, Ger.). pp 11 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The magnetohydrodynamic equilibrium of a resistive, low-density plasma in a model stellarator field was studied. The effect of inertia on plasma motion is treated exactly, and its influence on plasma loss determined. It is shown that the losses due to inertia are limited by the conditions for the existence of an equilibrium. (auth)

24400 ENCHANCED DIFFUSION IN A NONUNIFORM MAGNETIC FIELD. Puri, S. (Institut fuer Plasmaphysick, Garching, Ger.). pp 12 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A uniform electric field transverse to a spatially nonuniform magnetic field produces particle diffusion even when the electric field spectrum contains no dc component. This diffusion is additional to the usual E × B diffusion and occurs isotropically in the plane perpendicular to the magnetic field direction. (auth)

24401 STABLE MAGNETOHYDROSTATIC EQUILIBRIA WITHOUT ROTATIONAL TRANSFORM. Lortz, Dietrich (Institut fuer Plasmaphysik, Garching, Ger.). pp 13 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The general class of vacuum fields $B = \nabla\phi$ with closed lines of force in the neighborhood of a given closed curve C is investigated, where B is tangential on C and $q = \oint |\beta|^{-1}\, dl$ has a maximum on C. (auth)

24402 TOKAMAK EQUILIBRIUM. Johnson, J. L.; Greene, J. M.; Weimer, K. E. (Princeton Univ., N. J.). Contract AT(30-1)-1238. pp 15 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Axisymmetric hydromagnetic equilibria are obtained to determine how externally applied magnetic fields, which support the configuration, must be altered to compress the plasma to a smaller major radius and thus obtain additional heating. (auth)

24403 CURRENT DIFFUSION AND ENERGY BALANCE IN TOKAMAK SYSTEMS. Dnestrovskii, Y. N.; Kostomarov, D. P.; Pavlova, N. L. (Moscow State Univ.). pp 17 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Transport processes in tokamak systems with anomalous resistance and electron thermal conductivity of plasma are considered. The computational results are in good agreement with the experiments on two tokamak devices. (auth)

24404 ENERGY BALANCE AND LIFETIME OF IONS IN PLASMA OF TOKAMAK T-3. Artsimovich, L. A.; Glukhov, A. V.; Gorbunov, E. P.; Petrov, M. P. (Inst. of Atomic Energy, Moscow. Ioffe Inst. of Physics and Tech., Lenigrad). pp 18 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The energy balance of ions in the tokamak device T-3 was examined using ion temperature, obtained from the analysis of energy spectrum of charge-exchange atoms. The values of ion energy lifetimes are given. It is shown that the ion energy losses are mainly caused by the classical heat conductivity, with trapped particles taken into account. (auth)

24405 PLASMA ENERGY IN TOKAMAK T3 FROM ELECTRICAL AND THOMSON-SCATTERING MEASUREMENTS. Gorbunov, E. P.; Ivanov, D. P.; Peacock, N. J.; Robinson, D. C.; Strelkov, V. (Culham Lab., Abingdon, Eng. Inst. of Atomic Energy, Moscow). pp 19 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The radial distributions of the electron density and temperature were measured as functions of time from photon scattering together with μ-wave interferometer measurements and compared with the total energy derived from the diamagnetic signal and the electrical waveforms. There is agreement between the two methods of estimating the plasma energy throughout the range of ohmic heating currents 40 to 150 kA and densities in the range 1 to 4.5×10^{13}

cm^{-3}. The transverse electron energy scales as the square of the current. Beta, with respect to the field of the current, is about 0.5 but increases with time to greater than 2 towards the end of the current pulse. Anomalous resistivity is observed under most plasma conditions. (auth)

24406 CONTAINMENT-TIME SCALING LAWS FOR PLASMA INJECTED INTO THE PROTO-CLEO STELLARATOR. Lees, D. J.; Bolton, R. A. E.; Hoffmann, C. R. J.; Medley, S. S.; Reynolds, P. (Culham Lab., Abingdon, Eng.). pp 25 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

It is important to establish the scaling properties of containment experiments in fusion since these can give useful guidance for the design of future experiments and illustrate the feasibility of a particular configuration as a possible reactor. Measurements were made on the scaling of containment time, with magnetic field and rotational transform, using the Proto–Cleo stellarator. (auth)

24407 PLASMA LOSS RATE IN THE CLASP STELLARATOR: COMPARISON WITH CLASSICAL DIFFUSION. Hugill, J.; Reid, G. W.; Axon, K. B.; Core, W. G. F. (Culham Lab., Abingdon, Eng.). pp 26 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Experiments on a small stellarator with l = 3 helical windings at field strengths up to 2000 G show nearly classical confinement of an argon plasma with $n_e \sim 10^{10}$ cm^{-3}, $T_e \sim 1$ eV. Experimental results are compared with the theory of Galeev and Sagdeev in the intermediate collisional regime. (auth)

24408 CONTAINMENT OF STEADY-STATE, ELECTRON-CYCLOTRON-HEATED PLASMA IN A STELLARATOR. Young, K. M.; Stodiek, W. (Princeton Univ., N. J.). pp 27 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Low-density steady-state hydrogen plasmas created by low-power electron cyclotron heating in the C stellarator show containment times close to the Bohm value. The relative containment increases by about a factor of three with helical transform, similar to results obtained for gun-produced and ohmic-heated plasmas. (auth)

24409 ION-CYLOTRON-RESONANCE HEATING EFFICIENCY IN THE MODEL C STELLARATOR. Hosea, J. C.; Sinclair, R. M.; Tamano, T. (Princeton Univ., N. J.). pp 28 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In an attempt to elucidate the cause of the reduced ICRH heating efficiencies previously observed on Model C, this efficiency was measured over a broader range of density than hitherto [$10^{10} \leq n(cm^{-3}) \leq 10^{13}$]. It was found that the efficiency is very strongly dependent on density, suggesting a density dependence of wave absorption in the beach and/or wave attenuation along the plasma column. (auth)

24410 NEW DATA ON PLASMA CONFINEMENT IN THE HIGH-SHEAR URAGAN STELLARATOR. Dikii, A. G.; Zalkind, V. M.; Konovalov, V. G.; (and others) (Physical-Technical Inst., Kharkov). pp 29 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Results of measurements of charged-particle confinement in the "Uragan" stellarator are given. The recycling effect was excluded by a spectroscopic procedure. (auth)

24411 EFFECT OF THE DIVERTOR MAGNETIC SURFACE ON TOROIDAL DRIFT OF A PLASMA. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Physical-Technical Inst., Kharkov). pp 30 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

It is shown that the divertor magnetic field decreases the toroidal drift of a plasma. This is caused by the fact that the polarization electric field is removed by currents that flow along magnetic lines of force and are shortened through the annular region of the divertor where the magnetic field equals zero. (auth)

24412 INFLUENCE OF SUPERIMPOSED SHEAR ON THE CONFINEMENT PROPERTIES OF THE WENDELSTEIN l = 2 STELLARATOR (W IIa). Grieger, G.; Eckhart, D.; Eisert, J.; (and others) (Institut fuer Plasmaphysik, Garching, Ger.). pp 32 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The effect of shear on the confinement properties of the Wendelstein stellarator was studied, and a strong influence observed. (auth)

24413 CONFINEMENT OF PHOTO-IONIZED PLASMA IN THE WENDELSTEIN l = 2 STELLARATOR (W IIa). Eckhartt, D.; Eisert, J.; Gierke, G.; (and others) (Institut fuer Plasmaphysik, Garching, Ger.). pp 33 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Photoionization of a neutral barium beam provides a steady-state point-like plasma source for the W IIa stellarator. The resulting confinement properties are essentially the same as those obtained with contact ionization on a tungsten sphere present in the confinement volume. (auth)

24414 PLASMA CONFINEMENT IN A TOROIDAL SCREW PINCH AT REDUCED β VALUES. Grossmann, P.; Wilhelm, R.; Zwicker, H. (Institut fuer Plasmaphysik, Garching, Ger.). pp 49 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The stability behavior of a toroidal screw pinch plasma with trapped parallel and antiparallel B_z fields is investigated. For trapped parallel field of $B_{z0} = 1$ kΓ, improved m = 1 stability was found as compared to the case $B_{z0} = 0$. The lifetime of the plasma is limited by instabilities starting in the pressureless plasma region surrounding the dense plasma column. (auth)

24415 PLASMA HEATING IN LOW-β COLLISIONLESS SHOCK WAVES. Martone, M.; Segre, S. E. (EURATOM–CNEN, Rome). pp 59 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Measurements of electron density and temperature (by 90° laser scattering) and magnetic field in the radial implosion of transverse shocks (or different Mach number) and in the oscillations following the implosions confirm the existence of a critical Mach number above which also ions are heated by collisionless phenomena. (auth)

24416 TURBULENT HEATING EXPERIMENT. de Kluiver, H.; Paans, A. M. J.; Piekaar, H. W.; Schrijver, H. (EURATOM–FOM, Jutphaas, Netherlands). pp 61 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Results of turbulent plasma heating by a current in a straight hollow cathode arc situated in a magnetic mirror are presented. The duration of the turbulent heating is controlled by short-circuiting the discharge capacitor at a preset time. Heating efficiencies are proven to be in the order of 3 to 4%. (auth)

24417 PLASMA TURBULENT HEATING IN VIKHR-3 TOROIDAL DEVICE. Demidov, B. A.; Fanchencko, S. D. (Inst. of Atomic Energy, Moscow). pp 62 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Plasma turbulent heating and loss mechanisms in the "Vikhr-3" closed magnetic trap were studied. The plasma was confined in a longitudinal magnetic field B_z and outward-rising quadrupole field B_y combination. A twice-repeated current pulse technique was developed to test the dependence of heating and losses upon initial conditions. (auth)

24418 TURBULENT HEATING OF IONS BY CURRENT OF A LINEAR DISCHARGE. Koydan, V. S.; Ponomarenko, A. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 63 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The investigation of the mechanism of ion heating in a turbulent linear discharge is one of the important problems. The dynamics of ion heating was investigated and the ion distribution function was determined by means of the multichannel analyzer of charge-exchange neutrals. (auth)

24419 MICROWAVE SCATTERING FROM DENSITY FLUCTUATING DURING TURBULENT HEATING. Sharp, L. E.; Hamberger, S. M. (Culham Lab., Abingdon, Eng.). pp 64 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The spectral distribution of density fluctuation is studied for the case of current-driven turbulence using the collective scattering of 2-mm microwaves. Preliminary results show short fluctuations at frequencies above the ion plasma frequency and characteristic of ion-electron streaming instability. (auth)

24420 ELECTROSTATIC POTENTIAL FLUCTUATIONS MEASURED DURING CURRENT-DRIVEN TURBULENCE. Jancarik, J.; Hamberger, S. M. (Culham Lab., Abingdon, Eng.). pp 65 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4th European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Results are presented of the fluctuation spectrum for a turbulently heated plasma. It is shown that three distinct types of spectrum can be seen, depending on initial conditions. The "anomalous" conductivity is shown to be related to the particular type of instability present. (auth)

24421 INTERACTION OF PLASMA BUNCHES WITH COMBINED VHF–MAGNETOSTATIC MIRROR IN THE RANGE OF ELECTRON CYCLOTRON RESONANCE. Golovanivskii, K. S.; Douger-Jabon, V. D. (Patrice Lumumba Univ., Moscow). pp 83 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The possibility of setting aside the cone-loss leakage in a mirror-confined plasma, using a vhf field near electron-cyclotron resonances, is discussed. (auth)

24422 PLASMA TRAPPING AND MICROINSTABILITIES IN THE PHOENIX II EXPERIMENT. Thompson, E.; Sweetman, D. R.; Murphy, E. G.; Church, M. J. (Culham Lab., Abingdon, Eng.). pp 85 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The existence of plasma trapping in a high-energy-neutral injection experiment is demonstrated. An estimate of the observed ion lifetime against loss due to microinstabilities was also made and found to be independent of ion density. (auth)

24423 INVESTIGATION OF PLASMA DECAY IN THE PR-6 DEVICE. Baiborodov, Yu. T.; Gott, Yu. V.; Ioffe, M. S.; Sobolev, R. I.; Yushmanov, E. E. (Inst. of Atomic Energy, Moscow). pp 86 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Disappearance of ions of various energies was measured during the decay of plasma with the initial density of 10^{12} cm^{-3}. The results obtained indicate that nonclassical mechanism of losses should exist in the initial stage of the decay. (auth)

24424 LOSS-CONE MODES IN INHOMOGENEOUS MEDIA. Berk, H. L.; Pearlstein, L. D.; Cordey, J. G. (Univ. of California, Livermore). pp 89 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A general treatment of standing-wave loss-cone modes is presented in a spatially inhomogeneous medium. Critical scale lengths for stability are found. (auth)

24425 PLASMA CONTAINMENT IN THE MAGNETIC WELL MTSE II. Ashby, D. E. T. F.; Bydder, E. L.; Hill, J. W.; Hughes, M. H.; Mason, D. W. (Culham Lab., Abingdon, Eng.). pp 90 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

MTSE II is a large pulsed magnetic well, filled by injection from a plasma gun. Experiments show that ion scattering is not caused by Coulomb collisions, although the energy transfer between ions and electrons does appear to be classical. Electric fields of ~1 V/cm are observed at frequencies up to ω_{ci}. (auth)

24426 HOT IONS AND DIFFERENTIAL ROTATION IN A NON-MAXWELLIAN PLASMA WITH A STATIC PARALLEL ELECTRIC FIELD. Hopfgarten, N.; Johansson, R. B.; Nilsson, B. H.; Persson, H. (Royal Inst. of Tech., Stockholm). pp 91 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Energetic ions of a Penning discharge in a strongly inhomogeneous magnetic mirror field are investigated. The measurements strongly suggest a fast rotational drift with violation of the isorotation law, and non-Maxwellian velocity distributions. An explanation involving both parallel and transverse electric fields is proposed. In one of the mirror regions a shock-like structure is observed. (auth)

24427 PLASMA INJECTION AND ADIABATIC COMPRESSION EXPERIMENT (PIACE) BY FAST RISING MAGNETIC FIELD. Hirano, K.; Kishimoto, H.; Ushio, M.; Ito, H. (Osaka Univ.). pp 92 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

High-β plasmas from two conical theta-pinch guns are injected and collided with each other in the mirror field produced by four single turn coils. Observation by S.T.L. framing photographs shows that two plasma puffs seem to meet just at the center of the apparatus and stay about 16 μsec or longer. The main compression field, which rises to 3.0 Wb/m^2 within 1.4 μsec, is powered by 60-kV and 126-kJ fast condenser banks with crowbar circuit. (auth)

24428 PARTICLE LOSS FROM THE POLYTRON. Kilkenny, J. D. (Imperial Coll. of Science and Tech., London); Dangor, A. E. pp 93 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Single-particle calculations of the ion motion in the polytron configuration show that particles situated inside a volume close to the minor axis are contained indefinitely. Particles situated outside this volume are lost. Experimental confirmation of this loss region is presented. (auth)

24429 HIGH-FREQUENCY HEATING OF A DENSE FULLY IONIZED PLASMA. Lehnert, B.; Bergstroem, J.; Bures, M.; Tennfors, E. (Royal Inst. of Tech., Stockholm). pp 102 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A dense fully ionized plasma with a neutral gas blanket is confined in an internal ring device. High-frequency power of about 0.5 MW is absorbed by the plasma at the magneto-acoustic resonance. The plasma can be sustained when the power input exceeds a certain minimum level. The losses along the magnetic field affect the plasma balance at small fluid velocities, as expected from theory. There are indications that the plasma can be stabilized against flute disturbances by line-tying effects which are controlled by external means. (auth)

24430 ION CYCLOTRON EXCITATION AND EXTENDED CONTAINMENT BY RF FIELDS. Pool, M. L.; Arendt, Paul (Ohio State Univ., Columbus). pp 103 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

By means of two-phase cyclotron excitation ions can be driven to arbitrarily chosen energy values in the thermonuclear range and maintained in energy in prescribed areas. The orbital guiding centers walk toward the central axis of the magnetic bottle. Small-angle scattering losses in energy and in direction of motion are removed. (auth)

24431 INVESTIGATION OF HIGH-FREQUENCY WAVE ABSORPTION BY PLASMA BETWEEN ELECTRON CYCLOTRON AND LOW HYBRID FREQUENCIES. Galaktionov, B. V.; Golant, V. E.; Dyachenko, V. V.; Shcherbinin, O. N. (Ioffe Inst. of Physics and Tech., Leningrad). pp 104 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In experiments described, the conditions of hf wave absorption by plasma and efficiency of plasma heating were determined. The sharp boundaries of absorption and heating were revealed. Data on efficiency of electron and ion heating were obtained. (auth)

24432 INFLUENCE OF AN ELECTROSTATIC FIELD ON CYCLOTRON RESONANCE BEHAVIOR OF A PLASMA. Schram, D. C.; Manintveld, P.; Oord, E. (EURATOM-FOM, Jutphaas, Netherlands). pp 107 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The theoretically predicted influence of an electrostatic field on the energy gain of electrons at ecr is confirmed experimentally by measuring the loss tangent of the plasma as a function of an applied dc voltage. The applicability of this effect as a heating scheme is discussed in general terms. (auth)

24433 HIGH-ENERGY-DENSITY CONCENTRATION BY MEANS OF CYLINDRICAL OR SPHERICAL COLLIDING PLASMA LINER. Haegi, M.; Keller, R.; Linhart, J. G.; Robouch, B. V. (EURATOM-CNEN, Rome). pp 119 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Experimental results are reported on the structure of snow-ploughed cylindrical shells and on the axial magnetic field compressed by them. These results compare well with numerical calculations showing that the model used for describing the processes is realistic. (auth)

24434 ELECTRON HEATING BY LARGE-AMPLITUDE PLASMA WAVES IN A QUIESCENT PLASMA. Barbian, E.; Matitti, T.; Jurgens, B. (FOM-Instituut voor Atom- en Molecuulfysica, Amsterdam). pp 168 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Longitudinal Langmuir waves are used to heat the electrons in a Cs plasma. A narrow-band excitation where the axial temperature dependence shows a modulation correlated with a standing-wave pattern is compared to a broad-band excitation that gives a smooth temperature curve together with a moderate noise level. (auth)

24435 NUMERICAL EXPERIMENTS ON PLASMA HEATING VIA CONVECTIVE BEAM–PLASMA INSTABILITY IN FINITE-LENGTH ONE-DIMENSIONAL SYSTEM. Lin, A. T.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). pp 173 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A sheet model is used to investigate the effects of plasma thermal spread and inhomogeneity in the plasma density distribution on plasma heating due to a beam–plasma interaction. The electric field is found to be amplitude-modulated, and the inhomogeneity reduces the interaction but increases the average electron thermal velocity. (auth)

24436 HOT-ELECTRON CONFINEMENT IN MAGNETIC CUSP GEOMETRIES. Aihara, S.; Fujiwara, M.; Hosokawa, M.; Ikegami, H. (Nagoya Univ., Japan). Nucl. Fusion; 12: No. 1, 45-54 (Jan 1972).

A hot electron plasma is established by ECR (6.4 GHz) in a simple cusped magnetic field. The plasma thus generated consists of hot electrons, cold electrons, and helium ions. The hot-electron temperature is determined from x-ray spectra to be about 30 keV and the density of the hot electrons is of the order of 10^{10} cm^{-3}, which is about 10% of the cold-electron density. The effect of the cusp field is particularly noticeable in the electron-density distribution, which has a void at the center. Plasma decay times (10 to 60 ms) are observed to increase with the field current. There are several collision processes which cause the loss of hot electrons. A simple equation is derived that determines the confinement time of hot-electron plasma. The confinement of hot electrons by ECR wrapping is also studied. With a wrapping microwave power of 150 W, the decay time is observed to increase to more than three times that without the wrapping power. (auth)

24437 POSSIBLE MECHANISM FOR ENERGY LOSSES IN A TOKAMAK DEVICE. Pogutse, O. P. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 12: No. 1, 39-43 (Jan 1972).

A general expression is derived for the heat flux from a plasma column due to Coulomb collisions of electrons trapped in an electrostatic potential wave. In a particular case, when the electrons are trapped in drift waves, the calculated coefficient of electron thermal diffusivity is in qualitative agreement with the coefficient obtained by processing experimental data from a Tokamak system. (auth)

24438 ELECTROSTATIC CONFINEMENT OF AN ALKALI METAL PLASMA. Jaffe, Morry. New York; City Univ. of New York (1971). 115p. University Microfilms Order No. 72-5074.

Thesis.

A series of experiments were performed related to electrostatic confinement of a plasma within a radial potential well generated in part by a 12-keV peripheral beam of electrons in a low-β potassium plasma. The imposition of a beam of electrons about a Q-machine plasma column serves to deepen the radial potential well across that column. The transverse plasma flux is consequently decreased, and the peak ion density and endplate collector current rise an order of magnitude. The same holds true for injection of a thin envelope of 1- to 2-kV electrons from an impregnated cathode ring emitter. Both radial and terminal particle collectors were used to measure transverse flux. A theoretical calculation was made of the flux of ions in the plasma column with energy sufficient to surmount the potential well. From this, an expression was derived relating the ratio of I/n for one well depth to I/n for a different well depth. A comparison was made with suitable empirical data taken with the peripheral beam (deep well) and without the beam (shallow well) surrounding the column. Comparison was found to be quite good. The deepening of the well by this beam is attributed to its effect upon the end condition. Plasma cells were studied in this Q device under a great variety of conditions; their origin was found to be due to a circular beam of electrons from the periphery of the bombarding filament moving around the tungsten cathode and entering the column with considerable transverse as well as longitudinal velocity. The cells per se were not found to improve confinement. (Diss. Abstr. Int., B)

24439 HIGH FREQUENCY PLASMA HEATING IN A CLOSED MAGNETIC TRAP. Ovchinnikov, S. S.; Kalinichenko, S. S.; Shvets, O. M.; Tolok, V. T. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2326-9 (Dec 1971). (In Russian).

Results are presented of an experimental investigation of the heating of a toroid dense plasma performed by axially nonsymmetric waves. Resonant excitation of ion cyclotron waves and subsequent thermalization of their energy by a magnetic shore result in efficient heating of the plasma. A mean ion energy up to 450 eV is obtained for a plasma density of (2 to 5) $\times 10^{13}$ cm^{-3}. (auth)

24440 MAGNETIC DIFFUSION INTO A MOVING CYLINDRICAL INCOMPRESSIBLE PLASMA. Barrault, M. R.; Craig, A. D. (Univ. of Liverpool). J. Phys., D (London); 5: No. 3, 525-32 (Mar 1972).

The magnetic field diffusion into a moving cylindrical incompressible plasma is analyzed. For the case of outward diffusion, and under certain simplifying assumptions, quasi-steady solutions are found. The effect of radial divergence is dominant under these conditons. (auth)

Diagnostics

Refer also to abstract 24405.

24441 (NBS-TN-607) ERRORS IN PLASMA MEASUREMENTS BY THE MICROWAVE CAVITY TECHNIQUES. Persson, K-B; Johnson, E. G. Jr. (National Bureau of Standards, Boulder, Colo. Inst. for Basic Standards). Oct 1971. 64p. GPO $0.65.

A theoretical and experimental study was made of the microwave cavity techniques used in measuring electron density and collision frequency in transient plasmas. Sources of errors are discussed and certain calibration procedures are recommended to minimize the error. In particular, the abnormal negative glow discharge in helium is presented as an inexpensive reference plasma for calibration purposes. (auth)

24442 STUDY OF NONCYLINDRICAL Z PINCH BY HOLOGRAPHIC INTERFEROMETRY AND UV SPECTROSCOPY. Bernard, A.; Buges, J. C.; Jolas, A.; Genta, P.; Watteau, I. P. (Commissariat a l'Energie Atomique, Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). pp 52 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The electron density and electron temperature of a noncylindrical z pinch are studied experimentally by means of the double-exposure holographic interferometry technique and the ratio of two oxygen lines in the vacuum uv. Comparisons were made with computations. (auth)

24443 METHOD FOR THE DETERMINATION OF ELECTRON DENSITY AND TEMPERATURE IN AN INHOMOGENEOUS PLASMA. Vanhauwermeiren, R. (Univ., Brussels). pp 120 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A spectroscopic method was devised to give an estimate of the electron density and temperature, as a function of the depth, in a hydrogen inhomogeneous plasma. It is assumed that the plasma is in local thermal equilibrium. (auth)

24444 PLASMA DIAGNOSTICS USING LANDAU-DAMPED LONGITUDINAL WAVES. Dzoanh, Nguyen T.; Pinsky, Howard (Univ. of Notre Dame, Ind.). pp 121 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A method of measuring accurately the plasma temperature and density, using the Landau-damped electrostatic waves, is reported. It is based on the analysis of the Landau damping length and dispersion relation of longitudinal waves propagating in collisionless plasmas. This method is particularly useful when a magnetic field is involved, because the characteristics of the Langmuir probe is not reliable in this case. (auth)

24445 COMPARISON OF ION TEMPERATURES MEASURED WITH AN ION-SENSITIVE PROBE AND SPECTROSCOPIC DOPPLER BROADENING. Katusmata, I. (Osaka City Univ.); Otsuka, M.; Ishii, K.; Ikee, R. pp 122 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Ion temperature measurements were made in helium plasmas having densities $10^{13} \sim 10^{14}/cm^3$ with an ion-sensitive probe and Doppler broadening of the helium ion spectrum line of 4686 Å by means of a Fabry–Perot interferometer. Typical examples are given of characteristics of the probe taken at different radial positions in a plasma. (M.O.W.)

24446 MEASUREMENTS OF THE ION-VELOCITY DISTRIBUTION FUNCTION IN A SINGLE-ENDED Q MACHINE. Andersen, S. A.; Jensen, V. O.; Michelsen, P. (Danish Atomic Energy Commission Research Establishment, Risoe). pp 123 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An electrostatic energy analyzer with a resolution better than 0.03 eV was constructed and used to determine the ion-velocity distribution function at different conditions in a single-ended Q machine. The influence of a neutral gas on the distribution function was examined. Double-humped distribution functions were obtained. (auth)

24447 CONSTRUCTION OF ELECTRON DISTRIBUTION FUNCTIONS FROM LASER-SCATTERING SPECTRA. Williamson, J. H. (Culham Lab., Abingdon, Eng.); Clarke, M. E. pp 124 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The full three-dimensional electron velocity distribution function of a low-density plasma can be constructed from Thomson scattering spectra observed in several different directions. Most of the complications which arise at relativistic electron velocities can be avoided by placing a diffraction grating in the scattered laser beam. (auth)

24448 MAGNETIC FIELD MEASUREMENT BY LIGHT SCATTERING. Kellerer, L. (Institut fuer Plasmaphysik, Garching, Ger.). pp 125 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The conditions for measuring magnetic fields in plasmas by light scattering are discussed. In experimental observations of laser light scattered by a magnetized arc plasma, deviations from the normal thermal spectrum were measured. The observed spectrum fits best with the theoretical curve due to the probe-measured magnetic field. (auth)

24449 OBSERVATION OF MAGNETIC FIELD MODULATION OF THE THOMSON-SCATTERED LIGHT SPECTRUM IN A LABORATORY PLASMA. Evans, D. E.; Peacock, R.; Carolan, P. (Culham Lab., Abingdon, Eng.). pp 126 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A 2.7-Å band of the broad, nearly Gaussian spectrum of laser light scattered by a plasma in the presence of a 15-kG magnetic field was isolated and passed through a 0.1-Å-resolution interferometer. Magnetic modulation of the spectrum was detected. There is close agreement between the field strength calculated from the modulation and that measured by Faraday rotation. (auth)

24450 DIAGNOSTICS FOR HOT-ELECTRON, MAGNETICALLY CONFINED PLASMAS. Lichtenberg, A. J.; Schwartz, M. J.; Lieberman, M. A. (Univ. of California, Berkeley). pp 127 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Diagnostics were developed for measuring the temperature, density, velocity distribution, axial and radial profiles, and decay rate, of a hot-electron (T_e between 20 and 200 keV) plasma confined in a magnetic mirror field. Comparison among a number of diagnostics is made. It is shown that measurements of temperature, density, and axial profile can be considerably in error if the experimental results are compared with Maxwellian velocity distributions, rather than self-consistent, mirror distributions. (auth)

24451 DETERMINATION OF ELECTRON CONCENTRATION IN A STRONGLY ABSORBING PLASMA USING A TRIPLE MIRROR LASER INTERFEROMETER. Burakov, V. S.; Zheludok, V. V.; Nechaev, S. V.; Naumenkov, P. A. Zh. Prikl. Spektrosk.; 15: No. 3, 410-14(Sep 1971). (In Russian).

A triple-mirror interferometer with a He–Ne laser was used in the diagnostics of an absorbing plasma. At a concentration of electrons $N_e > 10^{18}$, a noticeable absorption by the plasma of probing radiation is apparent. This is expressed in the degree of coupling of supporting and driving resonators. The introduction of supplementary focusing elements in the supporting resonator improved the coupling and permitted operation with a plasma having an optical thickness $kl \simeq 2$ to 2.5. The concentrations of electrons in a plasma in a pulsed lamp and in a capillary were 1.8×10^{18} and 3.6×10^{18} cm^{-3}, respectively. (tr-auth)

24452 CALIBRATED NEUTRAL-ATOM SPECTROMETER FOR MEASURING PLASMA ION TEMPERATURES IN THE 0.165- TO 10-keV ENERGY REGION. Barnett, C. F.; Ray, J. A. (Oak Ridge National Lab., Tenn.). Nucl. Fusion; 12: No. 1, 65-72 (Jan 1972).

A neutral spectrometer, consisting of a gas conversion cell and electrostatic energy analyser, was designed, constructed, and calibrated to measure the energy dispersion of energetic H or D atoms escaping a plasma. For energies less than 300 to 500 eV, the D-atom conversion to D^+ was greater than that of H-atom conversion to H^+. At a target density of 0.0125 torr-cm, the conversion efficiency of H in N_2 gas was 3.8×10^{-4} at 0.165 keV and increased to 3.3×10^{-2} at 10 keV. Results for H_2 conversion gas were an order of magnitude less than that of N_2 at the lower energies. (auth)

24453 APPLICATION OF THE ABEL INTEGRAL EQUATION TO OPTICALLY THIN PLASMA SOURCES. Stanisavljevic, M.; Konjevic, N. (Inst. of Physics, Belgrade). Fizika (Zagreb); 4: No. 1, 13-22(Jan 1972).

The testing of five most frequently used methods for computing the radial distribution of emitters or refractive indices in cylindrical, optically thin plasma sources is described. These methods were tested for four analytically soluble distributions by comparing the results of the numerical and analytical procedures. It is shown that for each distribution shape, depending on the accuracy of the input data, the most appropriate method can be selected. (auth)

24454 CONDUCTIVITY PROBE STUDIES IN RADIATING XENON PLASMA FLOWS PRODUCED BY SHOCK WAVES. Enomoto, Yuji; Gohda, Noriaki; Ezumi, Hiromichi (Hiroshima Univ.). J. Phys. Soc. Jap.; 32: No. 4, 1106-11(Apr 1972).

The electrical conductivity of xenon plasma produced by shock waves was measured by means of a conductivity probe similar to that described by Lin, Resler and Kantrowitz. Measurements were made for initial xenon pressures P_1 of 1 to 10 torr. The shock Mach numbers M_s ranged from 8.4 to 24.5. The maximum electrical conductivity agreed with theoretical values within a factor of two. For low shock Mach numbers, the decrease in electrical conductivity and the decrease in continuum emission intensity were much faster than the theoretical decreases based on continuum radiation loss. These results indicate that line radiation losses cannot be disregarded for low-shock Mach numbers. With increasing shock Mach numbers, it was found that, e.g., at P_1 = 2 torr and $M \gtrsim 20$, two observed decreases could be roughly explained by continuum radiation loss alone. (auth)

Kinetics (General)

24455 DYNAMICS OF A θ PINCH WITH A SUPERIMPOSED AZIMUTHAL MAGNETIC FIELD. El-Khalafawy, T. A.; Youssef, A. M.; Diatlov, V. G.; Volkov, Ya. F. (Atomic Energy Establishment, Cairo). pp 45 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare(1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A magnetohydrodynamic steady flow model, on the assumption of ideal plasma conductivity, was used. The theoretical calculations of the discharge radius and the period of magnetohydrodynamic oscillations are confirmed by experimental results. (auth)

24456 STEADY-STATE CURRENT SHEET SPEED IN MAGNETICALLY DRIVEN SHOCK TUBE. Chang, C. T. (Danish Atomic Energy Commission Research Establishment, Risoe). pp 77 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The discrepancy between the predicted and the measured steady-state current sheet speed is examined by taking into account the effect of impurity, finite compressibility, and finite conductivity. (auth)

Kinetics (Experimental)

24457 (TID-25947) MEASUREMENTS OF BROAD BAND ELECTRIC FIELD CORRELATIONS IN A TURBULENT PLASMA. Wing, William R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan 1972. 133p. Dep. NTIS.

Thesis.

A very broad-band (15 GHz), high-resolution (minimum time resolution <20 psec) correlator was built using sampling techniques. It was used in conjunction with high-temperature, impedance-matched probes to measure the rr component of the fluctuating electric field correlation tensor, $\langle E_r(\bar{x},t) \cdot E_r(\bar{x}-\bar{\lambda}, t-\tau)\rangle$ in the Oak Ridge turbulent mirror plasma device, "Burnout VI." Good agreement was found between the measured correlation and one of several calculated on the basis of different models of the instability driving the turbulence. (auth)

24458 LONGITUDINAL HEAT CONDUCTIVITY INVESTIGATION ON THE TUMAN DEVICE. Kaganski, M. G.; Kalmikov, S. G.; Shahovets, K. G. (Ioffe Inst. of Physics and Tech., Leningrad). pp 21 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Measurements of a temperature gradient along the magnetic field are made in the "Tuman" device. The measured plasma longitudinal heat conductivity coefficient is in agreement with theory at plasma densities 10^{14} to 10^{15} cm^{-3} and electron temperatures 10 to 20 eV. (auth)

24459 CONVECTIVE MOTION IN THE CLIMAX QUADRUPOLE PLASMA. Megaw, J. H. P. C.; Dellis, A. N.; Prentice, R.; King, C. D. (Culham Lab., Abingdon, Eng.). pp 23 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Measurements of plasma density and floating potential in CLIMAX indicate large-scale convective flow, transporting plasma across the flux surfaces. A mechanism is proposed by which this flow can be set up due to localized regions of cold gas. (auth)

24460 DIRECTIONAL ION FLUXES IN PLASMA CONFINED IN A TOROIDAL MAGNETIC TRAP. Berezhetskii, M. S.; Grebentshikov, S. E.; Kossi, I. A.; Shpigel, I. S. (Lebedev Inst. of Physics, Moscow). pp 31 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An analysis was made of experimental data of the directional motion of ions in the L-1 and Tor-2 stellarators. Diagrams of ion velocity vectors are discussed. (M.O.W.)

24461 ABSOLUTE MEASUREMENT OF RADIATION LOSSES FROM A THETA-PINCH PLASMA IN THE WAVELENGTH REGION FROM 10 TO 200 A. Engelhardt, W.; Koeppendoerfer, W.; Muenich, M.; Sommer, J. (Institut fuer Plasmaphysik, Garching, Ger.). pp 50 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A calibration procedure of a grazing-incidence spectrograph to allow for measurement of the radiation losses from a theta-pinch plasma is described. The losses turn out to be small compared to both the electron energy content and for heating the conduction losses. (auth)

24462 INFLUENCE OF ION COLLISIONS ON POPULATION DISTRIBUTION OF ATOMS IN A THETA-PINCH DISCHARGE. Engelhardt, W.; Koeppendoerfer, W.; Muenich, M.; Sommer, J. (Institut fuer Plasmaphysik, Garching, Ger.). pp 51 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Line intensities of the Balmer series as emitted in the early phase of a theta-pinch discharge show unexpected deviations from thermal-equilibrium conditions. Because of the high ion temperature (Ti/Te $\approx$ 10) ion collisions can compete with electron collisions in populating levels with quantum numbers $n \gtrsim 3$. (auth)

24463 Z PINCH DRIVEN BY MAGNETIC ENERGY STORAGE. DiMarco, J. N.; Burkhardt, L. C. (Los Alamos Scientific Lab., N. Mex.). pp 53 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

This experiment attempts to achieve a high-temperature (keV) z pinch by shock heating. The low-inductance energy source uses the technique of magnetic energy storage. Voltages of ~60 kV and currents of ~200 kA at a rate of 2×10^{12} A/sec are obtained with deuterium at 20 mTorr; shock velocities of 4.2×10^7 cm/sec are measured. The plasma column, grossly stable for 8 μsec, has an initial temperature of 1 keV as determined by pressure balance. (auth)

24464 TURBULENT CONDUCTIVITY OF PLASMA IN MAGNETIC FIELD WITH ZERO LINE. Syrovatskii, S. I.; Frank, A. G.; Khodshaev, A. Z. (Lebedev Inst. of Physics, Moscow). pp 66 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In the experiments described, the properties of current flow in plasma placed in a magnetic field with zero (neutral) line were determined. The current distribution in such a field was obtained.

The current region is rather broad in spite of the presence of a strong transverse magnetic field. Plasma conductivity is shown to be turbulent. (auth)

24465 MEASUREMENT OF TRANSVERSE VELOCITY DISTRIBUTION FUNCTION OF BEAM ELECTRONS IN A BEAM–PLASMA EXPERIMENT. Cabral, J. A.; Hopman, H. J.; van Wakeren, J. H. A. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). pp 69 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Measurements were made of the beam transverse energy as a function of the beam–plasma parameters. The transverse energy is seen to increase with the increase in the total radiated microwave power. It has been proved that the beam transverse energy is acquired at the cost of an axial deceleration of the beam electrons. With a simple model for the electron movement inside the analyzer one could determine the beam transverse velocity distribution function. (auth)

24466 LOW-FREQUENCY INSTABILITIES, DIFFUSION, AND ION HEATING IN A BEAM–PLASMA SYSTEM. Astrelin, V. T.; Buchelnikova, N. S.; Kudryavtsev, A. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 71 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The experiments were performed on a Q machine with plasma column diameter $2R = 4$ cm, its length $L = 80$ cm, $H \sim 800$ G, $n \sim 10^9$ to 10^{10} cm^{-3}, and $T_e \sim 0.2$ to 40 eV. The electrons were heated by high-frequency (~100 to 1000 Mc) plasma oscillations excited by an electron beam. The experiments were carried out in the electron-sheath regime. The plasma density and density oscillation amplitude were measured by Langmuir probes, and the electron and ion temperature by two-grid analyzers. The diffusion coefficient was found through direct measurement of the plasma flux from the column or through measurement of plasma decay time. (auth)

24467 SOME ASPECTS OF PLASMA FLOW IN AN ELECTROMAGNETICALLY DRIVEN SHOCK TUBE. Bensimon, J. (Faculte des Sciences, Paris); Lasek, A. pp 76 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An experimental study of plasma flow in an electromagnetically driven shock tube is reported. Special consideration is given to the behavior of the contact surface between shock-compressed gas and the discharge plasma. Comparison with the theory of stability is made. (auth)

24468 DENSE PLASMA FLOW FROM AN ELECTRODE CONIC SOURCE. El-Khalafawy, T. A.; Nofal, E. E.; El-Menshawy, M. F.; (and others) (Atomic Energy Establishment, Cairo). pp 110 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Density, velocity, and temperature of a plasma flow were measured as a function of time, distance, and intensity of the magnetic field. A change in the composition of the flow head-part was investigated. Parameters of plasma which appears in the tube under the effect of fast electrons and discharge emission were measured. (auth)

24469 FORBIDDEN OPTICAL TRANSITIONS INDUCED IN DENSE LITHIUM PLASMAS. Ya'akobi, B. (Univ. of Maryland, College Park); George, E. V.; Pawlak, M.; Bekefi, G. pp 115 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The line intensities and profiles of the forbidden 2P–3P transition of Li I and of its neighboring optical satellite (induced by collective electron plasma oscillations) were studied experimentally and theoretically. The plasma was produced in two ways: by exploding electrically a fine lithium wire and by illuminating a lithium surface with intense radiation from a CO_2 laser. (auth)

24470 EXPERIMENTS ON THE ROTATING MAGNETIC-FIELD PINCH. Berney, A.; Heym, A.; Hofmann, F.; Jones, I. R.; Lietti, A. (Centre de Recherches en Physique des Plasmas, Lausanne, Switzerland). pp 152 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The results and interpretation of measurements made on the 90-MW rotating magnetic field pinch are given. The progress made on a 720-MW experiment of the same type is also discussed. (auth)

24471 DIGITAL MEASUREMENT OF TURBULENT RESISTIVITY ON A SUB-MICROSECOND TIME SCALE. Schrijver, H. (EURATOM–FOM, Jutphaas, Netherlands). Physica; 57: No. 4, 526-35(15 Feb 1972).

In a turbulent heating experiment, the voltage and the current of an arc plasma are measured and recorded in digital form with a video-camera scanning system from oscilloscope pictures. The time resolution of this system is in the order of 20 ns. The time-dependent resistivity of the arc plasma is computed on a digital computer from the voltage and the current measurements. The numerical techniques include differentiation and filtering with the aid of a Fast Fourier Transform. (auth)

24472 INFLUENCE OF CONDITIONS IN THE NEAR-WALL DOUBLE LAYER ON THE ELECTRON ENERGY DISTRIBUTION IN THE PLASMA OF POSITIVE COLUMNS. Godyak, V. A.; Kuzovnikov, A. A.; Khadir, M. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 469-70(Jul-Aug 1971). (In Russian).

The effect of hf oscillations near the wall of a low-pressure positive column discharge on the electron energy distribution was studied. The effect obtained for the statistical heating of electrons during comparatively small (of the order of the electron temperature) high-frequency potentials may be utilized as a method for controlling the electron energy distribution in a plasma. (K.S.W.)

Kinetics (Theoretical)

24473 (JINR–P4-6083) FREQUENCY SPECTRUM OF THE LIGHT SCATTERED BY ELECTRONS IN THERMODYNAMICAL EQUILIBRIUM. Toropkov, N. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1971. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

Under the assumption that the electrons in the cloud are in the thermodynamical equilibrium with the Maxwellian velocity distribution, the frequency spectrum of scattered light was obtained. The spectrum is centered near the frequency of the incident wave with the drift, which is due to the Doppler effect. (auth)

24474 (TID–25941) SIMULATION OF THE ION DISTRIBUTION FUNCTION ABOUT A GRID WITH TIME VARYING POTENTIAL APPLIED BY NUMERICAL INTEGRATION OF THE ION VLASOV–POISSON EQUATIONS WITH EXPERIMENTAL COMPARISON. Estabrook, Kent G. (Tennessee Univ., Knoxville). Aug 1971. 152p. Dep. NTIS.

The one dimensional ion distribution function is found by numerically integrating the ion Vlasov–Poisson equations by a finite difference method for the phase space region surrounding a transparent grid with time varying potential applied. It was found that a time varying potential on a grid inherently produces ion bursts (pseudowaves) at all voltages and frequencies used. For $T_e \gg T_i$, frequency f_{pi} and amplitudes $\sim T_i$, the ion acoustic wave could be separated from the pseudowave. However, for frequencies greater than f_{pi}, and/or large amplitudes, the pseudowaves dominated the ion acoustic waves. (auth)

24475 DIELECTRIC FUNCTION OF A MAGNETOACTIVE DEGENERATE PLASMA AT RELATIVISTIC TEMPERATURE. Misra, P. S. C. S. Coll.; Puri, India); Roy, K. C. Indian J. Phys.; 44: No. 11, 599-600(Nov 1970).

Using the relativistic Boltzmann–Vlasov equation, an expression is derived for the frequency- and wave-number-dependent dielectric function of a degenerate electron plasma in the presence of a steady magnetic field, which is valid at temperatures satisfying the condition $mc^2 \ll KT$. The result is compared with those obtained for a plasma under different physical conditions. (auth)

24476 INFLUENCE OF ELASTIC COLLISIONS ON BEAM–PLASMA AMPLIFICATION IN THE ION PLASMA FREQUENCY RANGE. Leven, R.; Wisliceny, J. (Univ., Greifswald, Ger.). pp 73 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Beam–plasma interactions are considered, taking into account elastic collisions. The dispersion equation is found and solved for the case of drifting electrons. As an example, the amplification curves are plotted for electron–ion collisions. It is shown that, for sufficient high collision frequencies, the amplification is disturbed. (auth)

24477 THEORY OF BEAM–PLASMA INTERACTION. Kadomtsev, B. B.; Pogutse, O. P. (International Centre for Theoretical Physics, Trieste, Italy). pp 74 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Using as the simplest case of Langmuir-wave excitation by an electron beam, a new theory of beam–plasma interaction is proposed in which the generation of waves by bunched electrons is taken into account. This fact naturally leads to a final distribution function similar to two Maxwellians as was shown by many numerical calculations. (auth)

24478 HIGH-FREQUENCY ION–ELECTRON RESONANCES AND ABSORPTION IN STRONGLY MAGNETIZED PLASMA COLUMN. Messiaen, A. M.; Vandenplas, P. E.; Monfort, J.-L. (Ecole Royal Militaire, Brussels. Koninklijke Militaire School, Brussels). pp 100 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A fluid description of a bounded hot ion electron plasma is given that includes collision effects and a full electromagnetic treatment. The importance for rf absorption of the boundedness and of the hot character of the plasma is again emphasized. Experimental results agree satisfactorily with theory. (auth)

24479 FOUR-FLUID GENERALIZED MHD COMPUTER CODE FOR PARTIALLY IONIZED PLASMA. Hofmann, F. (Centre de Recherches en Physique de Plasmas, Lausanne, Switzerland). pp 153 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A computer program was developed that solves the generalized MHD equations (including electron inertia and drift velocity effects) for four fluids in one dimension. Results are presented and compared with measurements in the 90-MW rotating magnetic field pinch. (auth)

24480 VARIATIONAL ANALYSIS OF LINEARIZED VLASOV PLASMAS. Lewis, H. Ralph (Los Alamos Scientific Lab., N. Mex.). pp 181 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Analysis of linearized Vlasov plasmas by means of Hamilton's principle is illustrated by application to the initial-value problem for a neutralized, single-species plasma in one spatial dimension with periodic boundary conditions. For any degree of approximation and for arbitrary equilibrium velocity distributions, the problem is reduced to the solution of a system of ordinary differential equations in time with constant coefficients and time-dependent driving terms, and an exact particular solution was found. Numerical results are presented both for Maxwellian and non-Maxwellian equilibrium velocity distribution. (auth)

24481 PLASMA MOTION AND EQUILIBRIUM IN UNSYMMETRIC MAGNETIC FIELDS. Lehnert, Bo (Royal Inst. of Tech., Stockholm). pp 182 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Stationary plasmas confined by a magnetic field of short connection length and arbitrary shape are treated in terms of average motions in $\alpha\beta$ space defined by the field lines. Local fluid motions are allowed to take place. An average macroscopic fluid velocity is deduced in terms of which plasma equilibria can be investigated. (auth)

24482 NONLINEAR INITIAL-BOUNDARY-VALUE PROBLEM FOR CONVECTION, DIFFUSION, IONIZATION, AND RECOMBINATION PROCESSES. Wilhelm, H. E. (Colorado State Univ., Fort Collins). J. Math. Phys. (N. Y.); 13: No. 2, 252-6(Feb 1972).

The time-dependent convection-diffusion equation with ionization and recombination reactions is reduced by means of a nonlinear transformation to a differential equation, in which the nonlinear term represents a small perturbation. The general procedure of solution for the corresponding nonlinear initial-boundary-value problem is then established by means of the method of successive approximations. Uniqueness and convergence of the analytical solution are discussed. As applications, the temporal change of an initial distribution of electrons and ions is discussed for a finite box system and an infinitely extended system, respectively. (auth)

24483 ION RUNAWAY IN TOKAMAK DISCHARGES. Furth, H. P.; Rutherford, P. H. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett.; 28: No. 9, 545-8(28 Feb 1972).

The tokamak discharge, with its characteristic "enhanced resistivity," can permit singly charged ions to maintain themselves in the applied electric field at energies considerably above the mean thermal energy. (auth)

24484 CONVENTIONAL AND UNCONVENTIONAL THEORY OF ION-SOUND TURBULENCE. Biskamp, D. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 1, 85-7(Jan 1972).

In evaluating the conventional weak-turbulence equations for ion-sound turbulence somewhat more carefully, it is found that the theoretical value of the turbulent energy $W = \langle \tilde{E}^2 \rangle / 4\pi n T_e$ is consistent with observations on collisionless shock waves. However, calculating the anomalous resistivity η using this value of W, η turns out to be too large, regardless of whether simple quasi-linear theory or the strong-trapping theory of Dupree is used. (auth)

24485 LOW-FREQUENCY ELECTRIC MICROFIELD DISTRIBUTIONS IN A PLASMA CONTAINING MULTIPLY CHARGED IONS. O'Brien, John T. (Wisconsin State Univ., Platteville); Hooper, C. F. Jr. Phys. Rev., A; 5: No. 2, 867-84(Feb 1972).

A theory for calculating low-frequency component electric microfield distributions for a plasma containing more than a single ion species is developed. Calculations at a charged point are made for a plasma containing N^+ singly charged ions and N^{2+} doubly charged ions together with a charge neutralizing number of electrons, $N_e (N_e = N^+ + 2N^{2+})$. Three different ion ratios ($R \equiv N^{2+}/N^+$) are treated: R = 0.0, 1.0, and ∞. It is shown that the calculations allow for all ion–ion correlations to a high degree of accuracy. Numerical results are shown both graphically and in tabulated form. (auth)

24486 CONTINUUM THEORY OF CHARGED MIXTURES. Demiray, Hilmi. Princeton, N. J.; Princeton Univ. (1971). 116p. University Microfilms Order No. 72-2697.

Thesis.

Basic axioms of the theory of continuous media are employed to obtain the field equations and jump conditions of mixtures composed of charged species having chemical reactions and electromagnetic interactions. These are: conservations of mass and charge, balance of momenta, conservation of energy, principle of entropy, and balance laws of Maxwell–Lorentz theory of electromagnetic fields. Relativistic effects associated with large material velocities are not incorporated into the theory. Constitutive equations of mixtures irrespective of their internal constitutions are systematically derived. Thermodynamical restrictions are investigated. The constitutive equations are obtained for: (a) plasma of slightly ionized gases (including diamagnetic effects), (b) plasma with bound charges, and (c) a mixture composed of an elastic conducting solid and an electron gas continuum. The applicability of the present theory to elastic conductors is discussed. Finally, the solution of two problems is presented in order to illustrate the theory: One of these is concerned with the point charge in a plasma possessing bound charges and the other with the positive column in a longitudinal magnetic field. (Diss. Abstr. Int., B)

24487 THEORY OF FULLY IONIZED PLASMAS. Ecker, Guenter. New York; Academic Press, Inc. (1972). 357p. $19.50.

The following chapters are included: (1) equilibrium states of the Coulomb system, (2) nonequilibrium states of the Coulomb system—general description, (3) nonequilibrium states of the Coulomb system—description without individual particle correlations, (4) nonequilibrium states of the Coulomb system with individual particle correlations, (5) single-particle radiation, and (6) many-particle interactions with electromagnetic fields. An appendix on characteristic quantities of the plasma is included. (M.O.W.)

24488 MODEL OF PLASMA ACCELERATION SIMILAR TO THE SNOWPLOUGH MODEL. Jelen, J. (Technical Univ., Podebrady, Czech.). Czech. J. Phys.; 22: No. 3, 181-8(1972).

A model similar to the "snow-plough" model is examined. Provided that efficient acceleration takes place only in the front of the accelerated gas, where a relatively thin current sheet flows, the dependence of path and velocity on time, the distribution of gas density, and the energy transferred into the integral energy of plasma are found. Though the assumption of retaining the swept gas is not made, the results are very close to those of the "snow-plough" model. (auth)

24489 GENERALIZATION OF HOLSTEIN'S FACTOR. Pham Duc Wuong; Nguyen Hoe (Laboratoire de Spectroscopie des Plasmas, Paris). Phys. Lett.; 38A: No. 7, 521-2(27 Mar 1972).

The escape factor is introduced in the framework of the collisional-radiative model. Validity criteria are given as well as analytical formulas for various geometries. (auth)

24490 NON-MAXWELLIAN ION VELOCITY DISTRIBUTION AND THERMALIZATION RATE IN A PLASMA. Nishimura, K. (Univ. of California, Livermore). Phys. Lett.; 38A: No. 7, 535-6(27 Mar 1972).

A seemingly small deviation of the ion velocity distribution from a Maxwellian form may yield an unexpectedly different result in the conventional calculation of thermalization rate in a two-temperature plasma. (auth)

24491 NUMERICAL SIMULATION OF PARTIALLY NEUTRALIZED RELATIVISTIC ELECTRON STREAMS. Gritzo, Ludwig Adam. Albuquerque, N. Mex.; Univ. of New Mexico (1971). 187p. University Microfilms Order No. 72-4007.

Thesis.

The self-focusing of partially neutralized relativistic electron streams (Bennett pinch) is briefly discussed, and analytic solutions for idealized sets of conditions are reviewed. A computer code for the numerical simulation of the drifting of a relativistic electron stream through an initially neutral gas, with the concurrent production and motion of ions and secondary electrons, is discussed in detail. The simulation conditions are restricted to (1) electron streams whose transverse momentum is small compared with their longitudinal momentum, and (2) low gas pressures, where the background plasma current and current density are low compared with the injected current. Only those electromagnetic field components associated with static charge distributions and charge distributions in uniform motion are considered, i.e., radiation and induction fields are not included. Computed results are given for a 2.0-MeV, 17-kA, 0.055-m-radius electron stream with a nonuniform radial current distribution, injected into nitrogen gas at pressures ranging from 0.001 and 0.10 torr. The computed results compare favorably with experimental results of Graybill and Nablo obtained under similar conditions. Space- and time-resolved secondary electron and ion number densities and velocities are obtainbd from the computations. A listing of the computer code and a description of the input data follow the text. (Diss. Abstr. Int., B)

24492 ENERGY-DENSITY SPECTRUM OF THE ELECTRIC FIELD IN A TURBULENT PLASMA. Kim, S. H.; Wilhelm, H. E. (Colorado State Univ., Fort Collins). Phys. Rev., A; 5: No. 4, 1813-19(Apr 1972).

The Liouville equation describing the phase-space density in the multidimensional space formed by the Fourier amplitudes of the canonical-conjugate fluctuation fields in a conservative electron plasma is applied to the turbulence problem. The distributive function of the longitudinal velocity and electric field fluctuations in fully developed stationary turbulence is derived as that solution of the Liouville equation which maximizes the entropy of turbulent randomness. The spectral energy density of the electric field which represents a second-order moment of the phase-space density is evaluated by analytical integration for the general case of three-dimensional turbulence. The theory is applicable in the small- and medium-wave-number regions but not in the large-wave-number region where dissipation by Landau damping or collisional interaction is significant. (auth)

Production

24493 (AEC-tr-7292) REPORT ON ACTIVITIES, YEAR 1969. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati). Translation of report LGI-70/22/1. 80p. Dep. NTIS.

An experimental study of laser bombardment of a fixed target of solid deuterium was conducted. Discussions are given on the laser, instrumentation and diagnostic techniques, and solid plasmas. Some research on the construction of a Tokamak device is reported. (M.O.W.)

24494 (CLM-R-110) A LARGE DIAMETER Q-MACHINE PLASMA SOURCE WITH A ROTATIONALLY SYMMETRIC TEMPERATURE PROFILE. Burt, J.; Stott, P. E. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Jul 1971. 13p. Dep. NTIS (U. S. Sales Only). UK 15 pence.

The design and construction of a large-diameter Q-machine source for lithium and other alkali metal plasmas are described. In order to minimize plasma losses due to endplate temperature asymmetries, the plate is uniformly heated by electron bombardment from a rotating cathode. (auth)

24495 NONLINEAR EFFECTS IN A SYNTHESIZED PLASMA CONSISTING OF POSITIVE AND NEGATIVE ION BEAMS. Gabovich, M. D.; Naida, A. P. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz.; 62: No. 1, 183-8(Jan 1972). (In Russian).

Alteration of the individual velocity distribution functions due to collective interaction of positive and negative ion beams was investigated experimentally. It was found that phase focusing of the particles during development of beam instability results in a strong nonlinear interaction between the beams and in intense energy exchange between them. (auth)

24496 DISSOCIATIVE RECOMBINATION AS A POSSIBLE CAUSE OF THE AXIAL DENSITY DECAY IN A LONG DIFFUSED HYDROGEN PLASMA COLUMN. Masuzaki, M.; Tsuzuki, T. (Nagoya Univ., Japan). Phys. Lett.; 38A: No. 6, 441-2(13 Mar 1972).

Remarkable axial decay of the plasma density was observed in a long diffused hydrogen plasma column produced in the QP machine. The dissociative recombination process of hydrogen molecular ions is proposed to be a possible explanation for this decay. (auth)

24497 ECR-GENERATED NOBLE GAS PLASMAS IN STELLARATOR W IIa. Ellis, R. A. Jr.; Eckhartt, D. (Institut fuer Plasmaphysik, Garching, Ger.). pp 34 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Argon and xenon plasmas were produced by electron cyclotron resonance in the W IIa stellarator. Densities ranged from 3×10^8 to 2×10^{11} cm^{-3} and electron temperatures from 4 to 12 eV. The confinement time was estimated to be five to ten times the Bohm time. The general features of the density versus rotational-transform curves were similar to those observed with barium plasmas produced by contact ionization, except for some cases with xenon. (auth)

24498 PRE-IONIZATION STUDIES FOR TOROIDAL HIGH-BETA EXPERIMENTS. Eberhagen, A. (Institut fuer Plasmaphysik, Garching, Ger.). pp 43 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Pre-ionization is achieved in toroidal geometry by induced azimuthal currents. Favorable breakdown properties down to filling pressures of 3 mTorr D_2 and suitable pre-ionization plasmas were established by application of an rf predischarge and superposition of small azimuthal magnetic fields with only 10 kV potential difference around the 2-meter-long torus circumference. (auth)

24499 MICROBE: MICROWAVE IONIZATION IN A CROSSED BEAM EXPERIMENT. Cattanei, G.; Wegrowe, J.-G. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). pp 98 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A new plasma source using a microwave power focused on a neutral beam was developed. Some results are presented. (auth)

24500 FUSION BY LASER-DRIVEN FLAME PROPAGATION IN SOLID DT TARGETS. Bobin, J. L.; Tonon, G. F. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). pp 112 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

After a review of plasma flow properties, inequalities anal-

ogous to the Lawson criterion are derived, and conditions for a positive energy balance are discussed. (auth)

24501 EXPERIMENTS ON A LASER-PRODUCED OVERDENSE PLASMA. Schlueter, J.; Winkelmann, W. (KFA-EURATOM, Juelich, Ger.). pp 113 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The optical thickness of a laser-produced plasma was measured as a function of wavelength. For power densities $>2 \times 10^{10}$ W/cm^2 the plasma becomes optically thick at wavelengths shorter than the wavelength of the ruby laser. It is concluded that the electron density is $\geq 8 \times 10^{21}$ cm^{-3}. (auth)

24502 INVESTIGATION OF LASER-PRODUCED PLASMA IN A MAGNETIC FIELD. Schwirzke, F. (Naval Postgraduate School, Monterey, Calif.). pp 114 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The influence of finite conductivity on the dynamics of a laser-produced plasma was studied. The expanding plasma forms an elliptical shell of hot plasma due to enhanced resistive heating of the electrons at the plasma field boundary. The long-lasting plasma shell could be utilized as a target plasma in neutral beam injection mirror machines. (auth)

24503 PRODUCTION OF QUIESCENT PLASMAS IN A MAGNETIC FIELD BY A BEAM–PLASMA DISCHARGE. Bollinger, D.; Boyd, D.; Liu, H.; Seidl, M. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev. Lett.; 28: No. 12, 723-6(20 Mar 1972).

Very quiet, steady-state plasmas in axial magnetic fields with density fluctuations less than 0.1% may be produced in a beam–plasma discharge. The dependence of the density and electron temperature on the discharge parameters are in accordance with the predictions of a one-dimensional plasma model. (auth)

24504 DEMONSTRATION OF COLLISIONLESS INTERACTIONS BETWEEN COUNTERSTREAMING IONS IN A LASER-PRODUCED PLASMA EXPERIMENT. Dean, Stephen Odell. College Park, Md.; Univ. of Maryland (1971). 160p. University Microfilms Order No. 72-2581.

Thesis.

The width, time development, and ambient pressure dependence of a collisionless interaction front were studied using fast photography, shadowgraphy, and electric potential probes. The object of the work was to investigate the expansion of a laser-produced plasma through an ambient plasma, under conditions where the mean free path for binary momentum-transfer collisions was larger than the total expansion radius. The expanding plasma was formed by irradiating a 0.25 mm diameter lucite ($C_5H_8O_2$) fiber with a high-power (60 J, 30 to 45 ns) neodymium-doped glass laser. Calculations, confirmed by spectroscopic observations, predicted a significant degree of photo-ionization of the ambient nitrogen gas in the vicinity of the laser-produced plasma. The regime studied corresponds to $\sqrt{kT_e/m_i} < U < \sqrt{kT_e/m_e}$, where U is the velocity of radial expansion of the laser-produced plasma. (TSS) (Diss. Abstr. Int., B)

24505 PRODUCTION OF PLASMA WITH A CO_2 TEA LASER FROM SOLID HYDROGEN TARGETS. Buechl, Klaus Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). J. Appl. Phys.; 43: No. 3, 1032-7(Mar 1972).

A hydrogen plasma is produced with a CO_2 TEA laser of about 1 MW power. The plasma is investigated with probes, streak and short-time photography, transmission measurements, holographic interferometry, and shadowgrams with a ruby laser. The measurements are compared with a theory of plasma production by laser from solid targets and good agreement was found. Recombination is found to be important in this experiment. (auth)

Stability

Refer also to abstracts 24422 and 24591.

24506 (UNICP/SR-81) LITERATURE SURVEY ON PLASMA INSTABILITIES. VOLUME II. ABSTRACTS. PART A. Auer, G.; Cap, F.; Floriani, D.; Gratzl, H.; Weil, J. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 15 Jun 1971. 266p. NTIS.

This part contains 221 abstracts. (M.O.W.)

24507 (UNICP/SR-82) LITERATURE SURVEY ON PLASMA INSTABILITIES. VOLUME II. ABSTRACTS. PART B. Auer, G.; Cap, F.; Floriani, D.; Gratzl, H.; Weil, J. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 15 Aug 1971. 272p. NTIS.

This part contains 278 abstracts. (M.O.W.)

24508 (UNICP/SR-83) LITERATURE SURVEY ON PLASMA INSTABILITIES. VOLUME II. ABSTRACTS. PART C. Auer, G.; Cap, F.; Floriani, D.; Gratzl, H.; Weil, J. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 15 Aug 1971. 207p. NTIS.

This part contains 229 abstracts. (M.O.W.)

24509 (UNICP/SR-84) LITERATURE SURVEY ON PLASMA INSTABILITIES. VOLUME II. ABSTRACTS. PART D. Auer, G.; Cap, F.; Floriani, D.; Gratzl, H.; Weil, J. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 15 Aug 1971. 219p. NTIS.

This part contains 210 abstracts. (M.O.W.)

24510 THERMALIZATION OF AN ION BEAM IN A PLASMA. Okamoto, Y.; Tamagawa, H. (Nagoya Univ., Japan). Phys. Lett.; 38A: No. 6, 453-4(13 Mar 1972).

Collisionless thermalization of ions resulting from the interaction of an ion beam with a plasma under conditions when the beam excites an ion-acoustic instability is studied. (auth)

24511 DRIFT WAVES AND PLASMA DIFFUSION IN A STRAIGHT STELLARATOR. Stott, P. E.; Burt, J. (Culham Lab., Abingdon, Eng.). pp 36 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The effects of magnetic shear on unstable drift waves are studied in a straight l = 3 stellarator. Increasing the shear reduces the amplitude of the instability and also the cross-field diffusion coefficient. (auth)

24512 HIGH β THEORY: A REVIEW OF PINCH-PLASMA STABILITY. Grossman, W. (Institut fuer Plasmaphysik, Garching, Ger.). pp 37 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An outline is given of progress towards understanding instabilities in high-β plasmas. Theoretical results are compared with experiment wherever possible. (auth)

24513 REQUIREMENTS FOR STABILITY OF CYLINDRICAL AND TOROIDAL PINCH DISCHARGES. Robinson, D. C. (Culham Lab., Abingdon, Eng.). pp 38 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The essential features for a stable diffuse pinch configuration are derived from the hydromagnetic energy principle. It is shown that for stability the pitch (length) must never possess a minimum and the $\overline{\beta_\theta}$ (i.e. average β with respect to the axial current) must always be less than unity. Stable configurations with $\beta \approx 40\%$ exist with reversed axial field outside the plasma, provided the axial flux has the same sign everywhere. Without field reversal, stable configurations with appreciable β are only possible when currents flow outside the plasma. (auth)

24514 HELICAL EQUILIBRIUM AND STABILITY EXPERIMENTS IN 3-M LINEAR THETA PINCH. Quinn, W. E.; Ribe, F. L.; Siemon, R. E. (Los Alamos Scientific Lab., N. Mex.). pp 40 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Helical l = 1 fields on a high-β plasma column are observed to produce a helical equilibrium and to induce I_z currents in the plasma. The m = 1 instability growth rates are reduced by applied I_z currents. (auth)

24515 m = O TEARING-MODE INSTABILITY IN LINEAR THETA PINCH WITH TRAPPED REVERSE MAGNETIC FIELD. Koenen, L.; Noll, P.; Waelbroeck, F.; Wituiski, H. (KFA–EURATOM, Julich, Ger.). pp 41 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Deuterium gas was preheated by a low-energy theta discharge and permeated by a slowly rising magnetic bias field B_0, and then compressed by a magnetic field of opposite polarity. The plasma evolution was followed by simultaneous streak pictures made at 8 windows in the central region of the coil (spacing 8 cm) and by measurement of the diamagnetism $\Delta\phi$ along the axis with 16 compensated magnetic loops. The average electron temperature T_e was derived from x-ray absorption measurements and from the occurrence of impurity lines. The radial distribution of the magnetic field in the midplane z = O was measured by a magnetic probe of 2 mm outer diameter. The growth time of the observed m = O instabilities is in good agreement with values predicted for the resistive tearing mode on the basis of a simplified model. (M.O.W.)

24516 NONLINEAR INSTABILITY THEORY OF PINCH. Callebaut, D. K. (State Univ., Ghent). pp 44 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The oscillation and instabilities of a MHD pinch are studied to second order in the amplitude of the perturbation. The stability criteria of the linear theory are not directly affected. Limits for the linear theory appear; singularities in the second-order coefficient do occur. (auth)

24517 STABILIZATION OF PINCH INSTABILITIES BY FORCE-FREE MAGNETIC FIELDS. Goedbloed, J. P. (EURATOM–FOM, Jutphaas, Netherlands). pp 47 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Stability of pinch experiments is discussed from the point of view that the outer region is approximately force-free. (auth)

24518 INSTABILITY OF ELECTROSTATIC WAVES IN COLLISIONLESS SHOCKS. Sanderson, J. J. (Univ. of St. Andrews, Scotland); Gary, S. P. pp 54 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A linear analysis is presented of electrostatic-wave instability in collisionless shocks propagating perpendicular to an applied magnetic field. E × B, VB, and Vn drifts are included, and the maximum growth rates are compared with those of the zero-magnetic-field ion acoustic instability. (auth)

24519 STABILITY OF MICROWAVE-HEATED PLASMAS. Guest, G. E.; Sigmar, D. J. (Oak Ridge National Lab., Tenn.). pp 84 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Magnetically confined plasmas, created and heated by electromagnetic fields near the electron gyrofrequency, can support several modes of instability driven by inherent temperature anisotropy or possible loss-cone effects. If $T_{||} \ll T_{\perp}$, both electrostatic and electromagnetic waves can grow in time; while if $T_{||} \rightarrow T_{\perp}$, electrostatic waves at the hybrid frequency can be driven unstable by the loss-cone effect. Relevant known criteria are used to describe the stabilization of the temperature-anisotropy modes as $T_{||} \rightarrow T_{\perp}$. A detailed analysis is reported of the electrostatic loss-cone mode, for which temporal growth rates greater than anticipated electron bounce frequencies are obtained only for electron densities near microwave cutoff. (auth)

24520 QUIESCENT ECR DISCHARGE PRODUCED WITH LISITANO ANTENNA IN A MIN.-B-FIELD CONFIGURATION. Goede, A.; Brakenhoff, G. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). pp 94 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From 4. European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The stabilization of low-frequency plasma instabilities in a min-B field is well known. Such fields are often produced by means of Ioffe bars. Such a field is created by adding to a magnetic mirror field the transverse field of permanent magnets. At not-too-high field strengths, this is a technically simple method to obtain a min-B-field configuration. In the ecr plasma, one gets a decrease of density fluctuation level from about 10% to 0.2%. (auth)

24521 COLLISIONAL DRIFT INSTABILITY IN A BOUNDED PLASMA. Nocentini, Aldo (Univ., Trieste, Italy. CNEN, Frascati, Italy). pp 147 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The influence of the cathodes on the drift instability of a Q-machine plasma, in which the ions are collisionless and the electrons are collision-dominated is investigated. It is shown that only ion-rich plasmas can support drift waves with parallel wavelength of the order of the length of the machine. (auth)

24522 COLLISIONAL DRIFT WAVES IN PRESENCE OF NONUNIFORM RADIAL ELECTRIC FIELDS. Bardotti, G.; Dobrowolny, M. (EURATOM–CNEN, Rome). pp 148 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Numerical results are presented on the stability of a low-β magnetized plasma column in the collision-dominated regime and in the presence of radial nonuniform electric fields. (auth)

24523 CHARACTERISTICS AND CONTROL OF DRIFT-TYPE INSTABILITY IN INHOMOGENEOUS LOW-β PLASMA. Friz, M.; Mueller, G.; Corbin, J. C.; Palmer, R. S. (Aerospace Research Labs., Wright-Patterson AFB, Dayton, Ohio). pp 149 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The stabilization of a drift-type instability at the edge of a Q-machine plasma column due to radial electric fields is discussed. Experimental results are compared with recent theories, and the excitation and stabilization mechanisms are discussed. (auth)

24524 DYNAMIC STABILIZATION OF PERFECTLY DIAMAGNETIC PLASMAS. Weibel, E. S. (Centre de Recherches en Physique des Plasmas, Lausanne, Switzerland). pp 150 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Different theoretical models for perfectly diamagnetic plasmas are briefly discussed. Three types of dynamic stabilization of plasma are described. Different parameters are included. (M.O.W.)

24525 STABILITY OF A ROTATING MAGNETIC-FIELD PINCH. Troyon, F. (Centre de Recherches en Physique des Plasmas, Lausanne, Switzerland). pp 151 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The stability of a column of plasma, surrounded by a concentric conducting cylinder and confined by a rotating magnetic field is discussed in the collisionless and collision-dominated limits. The assumption of a thin-skinned plasma is discussed. (auth)

24526 LINEAR SCREW-PINCH EXPERIMENT WITH DYNAMIC STABILIZATION. Becker, G.; Gruber, O.; Herold, H. (Institut fuer Plasmaphysik, Garching, Ger.). pp 154 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The growth of helical m = 1 instabilities observed in a linear high-β screw pinch can be reduced by means of a superposed oscillating B_z field, if its amplitude and its frequency are chosen appropriately. (auth)

24527 MAGNETIC FORCES FOR FEEDBACK STABILISATION OF HIGH-BETA PLASMA. Junker, J.; Newton, A. A.; Bodin, H. A. B. (Culham Lab., Abingdon, Eng. Institut fuer Plasmaphysik, Garching, Ger.). pp 155 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The effects of magnetic forces due to a current dipole on a straight theta-pinch plasma were studied. The column remains cylindrical and its motion agrees with simple theory. The application of these results to the feedback control of the m = 1 instability of a bulged theta pinch is discussed. (auth)

24528 STABILITY OF PLASMA IN HIGH-FREQUENCY AND CONSTANT MAGNETIC FIELDS. Demirkhanov, R. A.; Sidorov, V. P.; Soldatenkov, T. R.; (and others) (Physico-Technical Inst., Sukhumi, USSR). pp 156 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The questions of the stability and confinement of the plasma in hf and constant magnetic fields are considered in two principal cases of the mutual orientation of the constant magnetic field and plasma surface: parallel and perpendicular (which correspond to some extent to the closed and open systems, respectively). (auth)

24529 PARAMETRIC EXCITATION OF AN IONIC INSTABILITY BY A STRONG HF FIELD. Leprince, P.; Moisan, M. (Laboratoire de Physique des Plasmas, Orsay, France). pp 165 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Experimental results are presented which show a theoretically predicted ionic instability parametrically excited by an electric field with frequency $f_0 = f_{pe}/\sqrt{2}$, where f_{pe} is the electron plasma frequency. (auth)

24530 QUASI-LINEAR APPROXIMATION TO THE TWO-STREAM INSTABILITY. Hirsch, R. H. (Kernforschungsanlage, Juelich, Ger.); Denavit, J. pp 171 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The quasi-linear approximation to the two-stream instability is investigated, using a numerical solution of the Vlasov equation and neglecting mode coupling. A case for which the trapping time is much longer than the correlation time is considered, and the results are compared with quasi-linear theory. (auth)

24531 NUMERICAL EXPERIMENTS ON CONTRASTREAMING INSTABILITY IN A FINITE-LENGTH SYSTEM. Lin, A. T.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). pp 172 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The effects of a finite-length system and particle thermal spread on the contrastreaming instability are investigated by computer simulation using a sheet model. It is found that the rate of formation of vortices is reduced by the thermal spread, the vortex is eventually destroyed in a finite-length system, and a hysteresis loop in velocity space develops just before the destruction of the vortex. (auth)

24532 PLASMA INSTABILITIES CONNECTED WITH THERMONUCLEAR REACTIONS. Kolesnichenko, Ya. I.; Oraevskii, V. N. (Inst. of Physics, Kiev). pp 180 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A consistent analysis was made of the main types of instabilities in high-temperature plasma, which stem from the accumulation of thermonuclear-reaction products in thermonuclear devices. (auth)

24533 FLUCTUATION LEVELS CONNECTED WITH REACTIVE MARGINAL INSTABILITIES OF A MAGNETIZED PLASMA. Minardi, E. (EURATOM-FOM, Jutphaas, Netherlands). pp 184 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Some physical aspects and applications are discussed of an expression giving the probability distribution for special collective resonant electrostatic fluctuations. The latter should include the marginal reactive instabilities associated with massive energy transportation from the polarized plasma into the collective field. (auth)

24534 LOCAL POTENTIAL AND NONLINEAR STABILITY IN HYDROMAGNETICS. Herrnegger, F. (Innsbruck Univ.). pp 185 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The concept of a thermodynamic local potential is applied to the Bénard problem of hydromagnetics. In this way a new functional is derived which may be viewed as a generalized entropy production due to various dissipative and convective processes. Based on this result, a stability analysis including arbitrary nonlinearities is given. (auth)

24535 PASSIVE FEEDBACK STABILIZATION OF THE KELVIN–HELMHOLTZ INSTABILITY IN A THERMIONIC PLASMA. Carlyle, David Charles. Austin, Tex.; Univ. of Austin (1970). 214p. University Microfilms Order No. 72-2310.

Thesis.

An experiment designed to test the feasibility of passive feedback stabilization of the Kelvin–Helmholtz instability in a thermionically generated plasma is described. A segmented boundary in electrical contact with the plasma is utilized. The segments of the boundary are connected to one another and to a common ground through passive admittances. Investigations are conducted for magnetic fields B ~ 1 to 2 kG and for densities $n \sim 10^8$ to 10^{10} cm^{-3}. It is found that a passive network containing capacitance and resistance can reduce the amplitude of the transverse Kelvin–Helmholtz "edge-oscillation" by ~20 to 40%. The peak density shows an increase of ~10 to 30% when the oscillations are reduced by feedback. Spectrum analysis shows a decrease in the amplitude of all noise in a band from ~14.5 kHz to ~22.5 kHz. The experimental results are discussed in relation to a simple two-region model of the plasma. (Diss. Abstr. Int., B)

24536 EFFECTS OF WEAK COLLISIONS OF DRIFT-WAVE INSTABILITIES. Yu, Ming-young. Ann Arbor, Mich.; Univ. of Michigan (1971). 57p. University Microfilms Order No. 72-5019.

Thesis.

A model collision operator of the Fokker–Planck type is used to describe interactions between charged particles. The effect of these interactions appears as velocity-space diffusion and friction. An exact integral of the kinetic equation is obtained. In the limit of low collision frequencies, the effects of collisions on the ion-acoustic wave, the drift wave, and the drift-cyclotron wave instabilities are considered and compared with those of the other models. The present results indicate that this model differs considerably from that of Bhatnagar, Gross and Krook, and is a more appropriate collision model for a plasma. (Diss. Abstr. Int., B)

24537 EQUILIBRIUM AND STABILITY OF MHD FLUIDS BY DYNAMIC TECHNIQUES. Berge, G. (Univ. of Bergen). Nucl. Fusion; 12: No. 1, 99-117 (Jan 1972).

It is well known that mechanical systems in an unstable equilibrium position can be stabilized by dynamic techniques. Dynamic stabilization was also applied to unstable plasma equilibria. This review paper attempts to give a general introduction to these problems. A number of special cases within the framework of MHD are discussed. 90 references. (auth)

24538 VALIDITY OF THE QUASI-LINEAR APPROXIMATION FOR TURBULENT PLASMAS. Biskamp, D.; Welter, H. (Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 12: No. 1, 89-97 (Jan 1972).

The theoretical conditions for the applicability of the quasi-linear theory (QLT) are formulated and, to investigate the importance of these conditions, numerical experiments are performed on two different types of weak one-dimensional plasma instabilities. It is found that the behavior of the bump-in-tail instability is consistent with QLT (saturation field energy $\langle E^2 \rangle / 8\pi$ nT ~ linear growth rate γ) if these conditions are satisfied, while in the opposite case, trapping stabilization is important (trapped-particle bounce frequency $\omega_b \sim \gamma$). The weak symmetric two-stream instability never satisfies the criterion for QLT validity, since all particles that are supposed to diffuse are trapped ($\Delta v_{diff} \sim \Delta v_{trap}$). Incidentally, the first saturation level predicted by QLT is the same as given by the condition for trapping stabilization, $\omega_b \sim \gamma$. However, the important deviation from the weakly turbulent behavior is apparent from the coherent mode-coupling process, which becomes (relatively) stronger, the weaker the instability. (auth)

24539 ANISOTROPIC EQUILIBRIUM FOR A HIGH-β THETA-PINCH. Schaffer, M. J. (Univ. Tecnica del Estado, Santiago). Nucl. Fusion; 12: No. 1, 59-64 (Jan 1972).

An equilibrium solution to the Vlasov equation for a high-β plasma column with an applied uniform magnetic field B_z is the Maxwellian-like anisotropic distribution, $f \propto \exp\{-[U + (mv_\theta + qA_\theta)^2 r^2/2mr_0^2]/T\}$, where the radius r_0 characterizes the excess radial pressure compared to the azimuthal pressure. This is the sort of distribution that might result from the rapid expansion and trapping of a plasma following a sudden heating by a laser or an intense electron beam, before the ions relax by collisions. The weak anisotropy permits the existence of a large, nearly field-free interior bounded by a thinner interface of a thickness of the order of a few ion Larmor radii with only a weak electron–ion streaming. Approximate analytical expressions are obtained for the interface thickness and the plasma radius, and they are compared against numerically calculated plasma-density profiles. (auth)

24540 DYNAMIC STABILIZATION OF MAGNETOHYDRODYNAMIC INSTABILITIES BY MEANS OF MULTIPOLE HIGH-FREQUENCY FIELDS. Sidorov, V. P.; Soldatenkov, T. R. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 12: No. 1, 73-84(Jan 1972).

Problems of stability in a plasma column which has a hybrid current (constant and variable in time) flowing through it are discussed. The variable component of the current is, generally speaking, a helical multipole with zero skin layer. The constant-current component exhibits either a skin effect or a uniform distribution over the column cross section. The perturbations considered are of the surface-wave type, since it is known that this type of perturbation plays a major role in a current plasma with a free boundary. Analysis of the dispersion equation obtained indicates that the application of high-frequency multipole fields reduces the critical q-value in current systems. From the physical point of view, stabilization is brought about by the presence of a time-averaged magnetic well and by the effect of dynamic shear. It was found that the effectiveness of stabilization increases as the multipolarity of the high-frequency field, a fact which is explained by increased depth (on average) of the magnetic well. This requires an increase in the radio-frequency circuit currents, however, which means that circuits with a high Q-factor must be used. The extent that the high-frequency circuit (helical conductors) can assume the role of a stabilizing sheath is shown. In the model adopted here, the circuit is taken to be an anisotropically conducting sheath and the helical pattern is reflected; perturbations are found on which the circuit exercises a stabilizing effect. These are perturbations whose helix coincides with that of the high-frequency circuit currents projected on a cylindrical plasma surface of radius "a". All other perturbations remain unaffected by the circuit: the perturbed currents do not form a circuit because the helices of the perturbation and the circuit are crossed. (auth)

24541 DRIFT-WAVE STABILITY UNDER LINEAR THETA-PINCH CONDITIONS. Mikhailovskii, A. B. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 12: No. 1, 55-8(Jan 1972).

The growth rate and boundary of a drift-dissipative instability in a plasma in which the value of the parameter β is finite ($\beta = 8\pi p_0/B_0^2$, p_0 being the pressure of the plasma and B_0 the magnetic field inside it are studied). It is shown that the growth rate becomes small compared to the frequency at $\beta > \nu_e/\omega_{Be}$, where ν_e is the electron–ion collision frequency, and ω_{Be} is the electron cyclotron frequency. The development of this instability proves impossible at $\beta > \max[(m_e/m_i)\nu_e/\omega_*, \rho_i/a]$, where m_e and m_i are the masses of the electron and ion, ω_* is the drift frequency, ρ_i is the ion Larmor radius, and a is a dimension characterizing the inhomogeneity of the plasma. This is in agreement with the results of experiments conducted by Bodin and Newton on the diffusion of a plasma in a linear theta pinch. (auth)

24542 STABILITY REGIONS OF DISSIPATIVE TRAPPED-ION INSTABILITY. Rosenbluth, M. N. (Inst. for Advanced Study, Princeton, N. J.); Ross, D. W.; Kostomarov, D. P. Contract AT(30-1)-3927. Nucl. Fusion; 12: No. 1, 3-37(Jan 1972).

Conditions for the stability of the dissipative trapped ion mode in axisymmetric toroidal confinement systems are investigated, and the ranges of temperature and magnetic field for which the plasma is expected to be unstable are calculated numerically for several proposed Tokamaks. The collisional damping is studied as a boundary-layer problem in the velocity space of the trapped ions. The Fokker–Planck equation is solved by means of a variational form with the ordering $\nu_i R/r \ll \omega \ll 2\pi/\tau_i$, where R/r is the aspect ratio, $\nu_i R/r$ is the effective collision frequency, and τ_i is the bounce time. The relative damping rate is found to be proportional to $(\nu_i R/r\omega)^{1/2}[\ln(r\omega/\nu_i R)^{1/2}]^{-1/2}$ rather than $\nu_i R/r\omega$. This damping term is compared with the electron driving term, which is proportional to $r\omega/R\nu_e$, and with the Landau damping caused by resonant untrapped ions. The presence of a temperature gradient is found to be destabilizing. The Landau term provides relatively strong damping when $dT/dr = 0$, but changes sign when $d \ln T/d \ln n > 2/3$. In the latter case it is concluded that ion collisions are insufficient to stabilize the mode under typical operating conditions of the proposed machines. Finally, if $d \ln T/d \ln n > 1.75$ the ion collisional damping itself changes to growth, and the mode cannot be stabilized. (auth)

24543 ROLE OF THE INITIAL SUPPRESSION OF BEAM–PLASMA INTERACTION FOR SHORT EXPERIMENTAL DEVICES. Jungwirth, K. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; Phys.; 22: No. 2, 120-32(1972).

Conditions for excitation of the hf beam-instability in a relatively short ($L \lesssim \nu_b/\gamma$) beam–plasma system were studied. The beginning of the effective energy transfer from the beam electrons to the excited wave measured from the instant of their entrance into the system is delayed by a certain time t_{crit} that reaches its maximum value $t_{crit} \approx 3/2\ \gamma$ for a monoenergetic beam. If waves with the group velocity comparable to that of the beam grow up to a measurable value, only provided that the waves are effectively reflected on both ends of the system, the efficiency of the interaction is further lowered. The systematic change of the phase velocity of the excited wave leads to the interruption of the instability after a few such reflections. The theoretical results were confirmed by the experimental measurements on the ELMAN II machine. (auth)

24544 INSTABILITY OF TWO COUNTER-STREAMING GYRATING BEAMS OF ELECTRONS. Kopecky, V.; Preinhaelter, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 22: No. 1, 58-66(1972).

The linear theory of the two-beam instability of weak gyrating beams is investigated. Maximum growth rates of instabilities, instability limits, and frequencies of unstable waves are numerically determined. The aperiodic instability with $k_z v_{z0} = \omega_c$ (v_{z0} is the velocity of the beam along the magnetic field, ω_c is the cyclotron frequency, and k_z is the longitudinal wave number) and the instability with $\omega = \omega_c/2$ and with $k_z v_{z0} = \omega_c/2$ possess greatest growth rates. Dependence of growth rates on longitudinal and transverse components of the wave vector is investigated in detail. (auth)

24545 CYCLOTRON INSTABILITIES IN A FINITE PRESSURE PLASMA. I. Amano, Tsuneo; Shimomura, Yasuo; Yamamoto, Shin (Osaka Univ., Suita, Japan). J. Phys. Soc. Jap.; 32: No. 4, 1112-20(Apr 1972).

Cyclotron instabilities in a finite-pressure plasma are investigated without use of the electrostatic approximation. A "ring" distribution is taken for the ion velocity distribution function and the electrons are assumed cold. It is shown that the coupling between a quasi-electrostatic wave and an extraordinary ion cyclotron wave causes an instability with small growth rate. Finite plasma pressure has a stabilizing effect on the quasi-electrostatic instability and reduces the growth rate. (auth)

24546 RELATIVISTIC STREAMING EFFECTS ON ELECTROMAGNETIC INSTABILITY IN MAGNETOPLASMAS. Lakhina, G. S. (Indian Inst. of Tech., New Delhi); Buti, B. Phys. Rev., A; 5: No. 4, 1846-51(Apr 1972).

The electromagnetic waves propagating transverse to the direction of streaming of the contrastreaming plasmas in the presence of a uniform magnetic field are investigated. For electron plasmas these waves become unstable only for some bounded values of the streaming velocity U_0, namely $U_{min} < U_0 < U_{max}$. For relativistic streaming velocities, the electron thermal effects are destabilizing whereas for nonrelativistic streaming these are stabilizing unless $c^2k^2/\omega_{pe}^2 < 1/3$ and $k^2V_{te}^2/\Omega_e^2 \ll 1$ (k being the characteristic wave number, V_{te} the electron thermal velocity, Ω_e the electron cyclotron frequency, and ω_{pe} the electron plasma frequency). The magnetic field however reduces the region of instability no matter what the streaming velocity is. The effect of nonrelativistic-ion streaming is destabilizing, while that of the ion temperature is stabilizing. In the presence of a strong magnetic field, the effect of relativistic-ion streaming is also stabilizing. (auth)

Thermonuclear Processes

Refer also to abstract 24402.

24547 (AEC-tr-7291) THERMAL STABILITY OF FUSION REACTOR. Ohta, Mitsuru; Yamato, Harumi; Mori, Shigeru. Translated from Nippon Genshiryoku Gakkaishi; 13: No. 5, 259-66(1971). 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 36178. (M.O.W.)

24548 (BMBW-FBK-71-22) INVESTIGATIONS ON HIGH VOLTAGE PULSERS AND AMPLIFIERS FOR THE EXACT TIM-

ING OF THE IGNITION OF SPARK DISCHARGERS. Pillsticker, M. (Technische Universitaet, Brunswick (West Germany). Institut fuer Hochspannungstechnik). Dec 1971. 37p. (In German). Dep. NTIS (U. S. Sales Only).

Fundamental investigations on high-voltage pulsers and amplifiers required for low-jitter switching of several plasma physical experiments by triggered spark gaps are reported. New pulsers and amplifiers must be developed with allowance for important conditions (pulse amplitude up to ± 200 kV; rise time <10 nsec; max. pulse jitter ± 2.5 nsec) and new technological knowledge. The theoretical relations stated show whether the individual components of these tools are suitable. Novel cable amplifiers for pulses, switching problems, low-inductance triggered spark gaps, and the circuit diagrams used are explained. The tools developed and tested are described, and methods of generating and amplifying high-voltage pulses are given. (auth)

24549 (LA-4888) STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR A 12-MONTH PERIOD ENDING OCTOBER 1971. Motz, H. T. (comp.) (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 120p. Dep. NTIS.

MICROWAVES—absorption by plasma near electron plasma frequency, p. 73-75, (E)
PINCH DEVICES—design and testing of Scyllac 5-m toroidal sector experiment, p. 4-9
—plasma confinement in Scylla IV-3 with l = 1 and l = 0 helical fields, p. 28-34, (E)
—feedback system for Scylla and Scylla IV-3, p. 36-43
—plasma microinstabilities and sheath broadening in Scylla, p. 50-55
—research on toroidal z-, p. 56-72
PLASMA—heating and drift in Scyllac 5-m toroidal sector experiment, p. 9-27
—diffusion and heating in Scyllac 5-m toroidal sector experiment, p. 9-27
—confinement in Scylla IV-3 with l = 1 and l = 0 helical fields, p. 28-34, (E)
—injection into quadrupole magnetic fields, kinetics of, p. 80-85, (E)
PLASMA INSTABILITIES—microinstabilities and sheath broadening in Scylla devices, p. 50-55
PLASMA WAVE PHENOMENA—microwave absorption near electron plasma frequency, p. 73-75
THERMONUCLEAR REACTORS—plasma injection into quadrupole magnetic fields, kinetics of, p. 80-85, (E) (M.O.W.)

24550 (ORNL-TM-3694) ELMO BUMPY TORUS EXPERIMENT. Dandl, R. A.; Eason, H. O.; England, A. C.; Guest, G. E.; Hedrick, C. L.; Sprott, J. C. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 74p. Dep. NTIS.

A proposed experimental device is described that utilizes microwave-heated plasmas to modify the vacuum magnetic fields of a 24-sector bumpy torus. The expected properties of the device, the basic unknown elements to the clarified by the proposed experiments, and the possible future development of this approach toward a fusion reactor configuration are discussed. The essential and novel feature of this proposal is the utilization of steady-state, high-beta, mirror-confined, relativistic-electron plasmas, sustained and heated by microwave power, to stabilize the less-energetic toroidally confined plasma. Extensive experimental and theoretical studies of the microwave-heated plasmas in both straight and canted magnetic-mirror traps are reviewed from the point of view of the proposed torus. Single-particle confinement and the equilibrium and stability of the toroidal plasma are discussed in terms of the neoclassical theory of guiding-center drift and diffusion. It is concluded that with the proposed experimental facility it should be possible to obtain toroidally confined plasmas of 10^{13} particles/cm^3 with electron and ion temperatures $T_e \sim 1$ to 10 keV, $T_i \sim 0.1$ to 1 keV. The magnetic design is entirely conventional, using water-cooled, hollow copper conductors powered by 10 MW (dc). This power and the 30-kW (cw) microwave power are already in hand as are most of the diagnostic and control instrumentation, which have been developed in the course of a decade of research on such plasmas. (auth)

24551 (UCRL-73673) CONSIDERATIONS IN THE DESIGN OF FUSION REACTOR BLANKET STRUCTURES. Werner, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). 20 Jan 1972. 21p. (CONF-720110-1). Dep. NTIS.

From Fusion vacuum wall meeting; Washington, D. C. (27 Jan 1972).

In the design of moderating blankets surrounding plasmas it is often assumed that the first wall of the blanket is a "vacuum vessel." The consequence of this assumption is that a structure is created that is subjected to buckling instability problems because it is compressively loaded. It is the contention of the author that if this "vacuum vessel" approach is followed that structural, neutronic, and heat-transfer requirements cannot be satisfied simultaneously for the blanket. An alternate design is proposed in which the vacuum vessel is relocated on the magnet side of the blanket. (auth)

24552 POWER FROM NUCLEAR FUSION: PROBLEMS AND PROMISES. Drew, Howard R. (Texas Atomic Energy Research Foundation, Fort Worth); Drummond William E. Proc. Amer. Power Conf.; 33: 639-45(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The current status of fusion research is briefly reviewed. Some of the principal problems associated with the research are discussed. (M.O.W.)

24553 NUCLEAR FUSION REACTOR DESIGN: A REVIEW. Kristiansen, M.; Hagler, M. O. (Texas Technological Univ., Lubbock). pp 6 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Reasons for recent interest in fusion reactor design are discussed. The various efforts and studies underway, particularly in the USA, are described. The most significant results to date and the most apparent needs for further research are summarized. An appraisal is made of the current state of fusion reactor development, and possible development time schedules are discussed. (auth)

24554 STABILITY OF AXISYMMETRIC MULTIPOLE CONFIGURATIONS WITH CLOSED MERIDIONAL FIELD LINES. Rebhan, Eckhard (Institut fuer Plasmaphysik, Garching, Ger.). pp 14 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The stability of axisymmetric equilibria having meridional field lines only is investigated. In order to obtain stability, a hard core must be placed inside the plasma. The pressure distribution can be chosen such that absolute stability is obtained. However, a low-pressure layer extends up to the wall. (auth)

24555 DESIGN OF ALCATOR: THE MIT HIGH FIELD TORUS. pp 20 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

ALCATOR is a new plasma containment experiment characterized by high magnetic field, good control of symmetry, and copious diagnostic access. It will be operated first in the Tokamak mode with major radius R = 54 cm, minor radius a = 12 cm, and centerline field of 120 kG. The initial operation will exploit the high allowable plasma current density to explore the limits of ohmic heating, and to study the questions of enhanced resistivity and thermal transfer. Major aspects of the experimental design are described. (auth)

24556 MAGNETIC SURFACES IN A QUADRUPOLE. Williamson, J. H. (Culham Lab., Abingdon, Eng.). pp 22 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Local imperfections in the magnetic field can alter the topology of the magnetic surfaces, thereby allowing plasma to escape. A modest longitudinal magnetic field will maintain the nested surfaces near the plasma boundary, so that the residual topological charges near the separatrix become unimportant. (auth)

24557 EXPERIMENTS WITH A LINEAR (l = 1) HIGH-BETA STELLARATOR. Kaufmann, M.; Fuenfer, E.; Lotz, W.; Neuhauser, J. (Institut fuer Plasmaphysik. Garching, Ger.). pp 39 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A linear (l = 1) stellarator experiment with a helically shaped coil is described that is preparatory to a future toroidal experiment with a major diameter of 2.7 m. Stability is found to be

comparable with a pure linear theta-pinch or with an (l = 1) stellarator using a pair of conductors. (auth)

24558 INITIAL BEHAVIOR OF TOROIDAL DISCHARGES WITH PARALLEL MAGNETIC FIELD. Malesani, G.; Ellis, W. R.; Newton, A. A. (Univ., Padua. Los Alamos Scientific Lab., N. Mex. Culham Lab., Abingdon, Eng.). pp 42 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In a study of pre-ionization by the "current trapping" technique, the experimentally determined times for current growth suggest a two-stage multiplication process. Results in H_2 and D_2 at 10 to 40 mtorr in parallel fields ≤4 kG are presented and discussed. (auth)

24559 HIGH-INTENSITY ION BEAM FOR PLASMA INJECTION. Sindoni, E.; Eubank, H. P. (Princeton Plasma Physics Lab., N. J.). pp 97 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An experimental investigation was made of electron cyclotron resonance plasma accelerators as a source of high-intensity, low-energy (keV) ions in which ion current and electron and ion energies are related to rf power and gas pressure. (auth)

24560 NEUTRON PRODUCTION BY VORTEX ANNIHILATION IN PLASMA FOCUS. Bostick, W. H.; Grunberger, L.; Prior, W.; Nardi, V. (Stevens Inst. of Tech., Hoboken, N. J.). pp 108 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Image-converter photographs show that, when neutrons are being produced in the "plasma focus," the hot dense plasma is not concentrated on the axis but is in the regions where plasma vortex filament annihilation is taking place. Analytical solutions for particle distributions and fields are found that predict the existence of these plasma filaments. (auth)

24561 THEORY OF MAGNETIC BUNDLES IN DENSE FLOWING PLASMA. Nardi, V. (Stevens Inst. of Tech., Hoboken, N. J.). pp 109 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

An exact theory of plasma filaments observed in coaxial accelerators (CA) is derived from a steady-state ($\partial/\partial t = 0$) description of the three-dimensional flow of reacting deuterium plasma. Neutron and x-ray production at the muzzle of the gun is associated by this theory with the rapid variation with time of the magnetic structure of the filaments (bundles of helical field lines) in the final (focus) stage. (auth)

24562 NEUTRON-PRODUCTION MECHANISM IN THE PLASMA FOCUS. Potter, D. E. (Imperial Coll. of Science and Tech., London). pp 116 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Results from the application of a two-dimensional magnetohydrodynamic code to the plasma focus experiment provided good agreement with experiment in describing the dynamics and structure of the plasma focus. The behavior and parameters of the focus pinch produced in the numerical fluid model suggest two mechanisms for the production of neutrons. Estimates of the neutron yield are determined for each mechanism, and the neutron properties on the basis of the calculations are compared with experiment. (auth)

24563 SCALING LAWS OF PLASMA FOCUSES. Maisonnier, Ch.; Samuelli, M.; Robouch, B.; Pecorella, F. (EURATOM-CNEN, Rome). pp 117 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The variation of the neutron emission N_0 of a Plasma Focus device as a function of the voltage (U) and capacity (C) of the condenser bank was experimentally measured for 20 < U < 40 kV and 30 < W < 120 kJ. It is found that N_0 varies as $U^{4.5}$ and $C^{2.5}$. (auth)

24564 DENSITY, TEMPERATURES, AND NEUTRON MEASUREMENTS OF A PLASMA FOCUS. Baconnet, J. P.; Cesari, G.; Coudeville, A.; Patou, C.; Watteau, J. P. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). pp 118 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The plasma focus electron temperature and neutron emission are analyzed in space and time. Density and ion temperature are studied by schlieren pictures and Thomson scattering, respectively. Preliminary reports of recent studies with various capacitor banks are given. (auth)

24565 TEMPERATURE PROFILE IN A STEADY-STATE THERMONUCLEAR REACTOR. Rem, J.; Verboom, G. K. (EURATOM-FOM, Jutphaas, Netherlands). pp 179 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A steady-state, thermonuclear D–T plasma column, surrounded by a cold plasma was investigated by solving the MHD equations numerically. A solution in which the temperature falls to a low value at the boundary is found to exist only in a limited range of values for the characteristic parameters. Fuel is supplied and ash removed at the boundary. (auth)

24566 USE OF LASERS IN FUSION. Bobin, J. L. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Sci. Avenir; Special No., 57-61(1971). (In French).

Different nuclear fusion machine setups using lasers are briefly reviewed: irradiation of a granule with spherical expansion; irradiation of a target with short pulses; sustained radiative deflagration; injection into a magnetic bottle with a mirror or well configuration; and irradiation (superheating) of a plasma column. The use of laser light in plasma diagnostics is mentioned. The future of the various techniques is discussed. (France)

24567 NONLINEAR INTERACTION OF LASER RADIATION AND PLASMA. Yamanaka, C. (Nagoya Univ., Japan); Yamanaka, T.; Kang, H.; (and others). Phys. Lett.; 38A: No. 7, 495-6 (27 Mar 1972).

The neutron yield of thermonuclear fusion from a solid deuterium target irradiated by a laser beam of 20 GW at 2 ns was observed. The anomalous heating was introduced by the nonlinear parametric interaction of laser radiation and plasma. (auth)

24568 STABILITY OF HIGH-INTENSITY ELECTRON BEAM. Ikuta, Kazunari (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 32: No. 4, 1132-4(Apr 1972).

A stability condition is obtained for a general configuration of a high-intensity neutralized electron beam and is applied to cylindrical beam systems. Neutralized cylindrical beam systems are stable if the total beam current sufficiently exceeds 10^4 ampere. (auth)

24569 LARGE GAS-COOLED COILS GO SUPERCONDUCTING IN CULHAM'S LEVITRON. Cornish, D. N. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Cryogenics; 12: No. 2, 89-90(Apr 1972).

The large gas-cooled superconducting coils designed for use in the Culham Laboratory's Levitron and the successful series of tests carried out on these coils are described. (UK)

24570 APPARATUS FOR PRODUCING A HIGHLY CONCENTRATED BEAM OF ELECTRONS. Bennett, Willard H. U. S. Patent 3,639,849. 1 Feb 1972. Filed 20 May 1968.

The electron-beam-producing apparatus is arranged to collimate the beam, and the collimated beam passes into apparatus that produces a pinched discharge having a self-magnetic field. The pinched discharge pinches the already collimated electron beam, thus further concentrating the beam. (auth)

Wave Phenomena

Refer also to abstract 24431.

24571 (EUR-CEA-FC-614) PLASMA WAVE ECHOES. Etievant, C. (Commissariat a l'Energie Atomique, Fontenay-

aux-Roses (France). Centre d'Etudes Nucleaires). Sep 1971. 32p. (CONF-710920-11). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases, Oxford, England (13 Sep 1971).

Work done in connection with experiments on electron and ion plasma wave echoes is reviewed. The limitation of the perturbation theory is discussed and the saturation of echoes is explained using a more accurate model. Experimental results demonstrating the main features of both electron and ion plasma wave echoes and the effect of relaxation are presented. (France)

24572 (LBL-41) BACKSCATTERING OF ELECTROMAGNETIC WAVE FROM UNDERDENSE TURBULENT PLASMA. Kuo, Yu-Yun (California Univ., Berkeley. Lawrence Berkeley Lab.). 23 Sep 1971. Contract W-7405-eng-48. 67p. Dep. NTIS.

Thesis.

Backscattering of electromagnetic waves from a homogeneous underdense turbulent slab plasma was studied in a transport approximation of the multiple-scattering regime. The general feature of the multiple-scattered signal is quite different from that predicted by the Born approximation. There are two parameters that characterize the properties of the scattered signal. One is L_s, the ratio of the slab thickness to the scattering mean free path. The other is ξ, the ratio of the scattering loss to the collisional absorption. When $L_s \ll 1$, the cross section of the parallel polarization $\sigma_{||}$ obtained in the multiple-scattering regime remains the same as that gained from Born approximation. But in the region of $L_s \gtrsim 1$, the cross section $\sigma_{||}$ in multiple scattering will level off, while that in the Born approximation goes up as a linear function of L_s. The cross section of the cross polarization $\sigma_\perp$ of a backward-scattered signal has the same feature as $\sigma_{||}$, whereas $\sigma_\perp$ in the Born approximation is zero. The absolute magnitude of $\sigma_{||}$ and the relative ratio between $\sigma_{||}$ and $\sigma_\perp$ all depend on the parameter ξ. The calculation was applied to the ionospheric auroral phenomena. It was also found that the criteria for applying the Born approximation up to the critical density does not depend upon the electron density in the medium, but upon the parameter L_s. (auth)

24573 (MATT-883) INVESTIGATION OF ION WAVES. Dawson, J. M.; Kruer, W. L.; Rosen, B. (Princeton Univ., N. J. Plasma Physics Lab.). Feb 1972. Contract AT(30-1)-1238. 18p. (CONF-710921-3). Dep. NTIS.

From International symposium on dynamics of ionized gases; Tokyo, Japan (13 Sep 1971).

Investigations of (1) the nonlinear behavior of ion waves, (2) the growth and saturation of the ion-acoustic instability, and (3) the interaction of holes in the electron phase space with ions on a one-dimensional numerical plasma model are reported. For the nonlinear behavior of ion waves, a number of different effects were examined and analyzed. The steepening and breaking of an initial sinusoidal wave were considered. It was found that, for perturbations such that $\delta n/n \simeq k^2\lambda_D^2$, strong harmonic generation occurs. For sufficiently large amplitudes the waves break and ion trapping takes place. The precise amplitude at which this occurs depends strongly on the ratio of the ion temperature to the electron temperature. A typical value for a temperature ratio of 0.03 is $\delta n/n = 0.25$. The growth of the ion acoustic instability was found to be in agreement with linear theory. Its saturation level was found to be determined by the energy released when electrons became trapped by the ion waves and a simple theory for it is given. Finally, it was found that holes in the electron phase space can interact strongly with ions and that there can be an appreciable anomalous resistance associated with them. (auth)

24574 HIGHER HARMONICS OF ELECTRON OSCILLATION IN A BEAM-GENERATED PLASMA. Nakamura, Y. (Tokyo Univ.). Phys. Lett.; 38A: No. 6, 435-6(13 Mar 1972).

Intensities of the higher harmonics of standing electron oscillations in a beam–plasma system fall off exponentially with harmonic number. The second- and third-harmonic amplitudes vary proportionally with the fundamental one. (auth)

24575 EXPERIMENTAL OBSERVATION OF PARAMETRIC EXCITATION IN TONKS-DATTNER RESONANCES. Ikezawa, S.; Takamura, S.; Tanaka, Y.; Okuda, T. (Nagoya Univ., Japan). Phys. Lett.; 38A: No. 6, 393-4(13 Mar 1972).

It is shown that in a certain range of the hf power, the hf (T–D resonances) and the lf (ion sound wave and its harmonics) oscillations are parametrically excited in a certain region of the hysteresis loop. (auth)

24576 COLLISIONLESS SHOCK WAVES AND ANOMALOUS ELECTRON HEATING AT VERY LOW DENSITIES. Dippel, K. H.; Hoethker, K.; Hintz, E. (KFA-EURATOM, Julich, Ger.). pp 55 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics, Rome, Italy (31 Aug 1970). See CONF-700817.

Shocks were generated in a deuterium plasma by means of a theta pinch. Electron temperature and density measurements were obtained by 90° Thomson scattering using a 500-MW giant-pulse ruby laser. Various parameters of the experiment are discussed. (M.O.W.)

24577 MECHANISM OF ENERGY DISSIPATION IN COLLISIONLESS SHOCK WAVES. Chodura, R.; Keilhacker, M.; Kornherr, M.; Niedermeyer, H.; Steuer, K.-H. (Institut fuer Plasmaphysik, Garching, Ger.). pp 56 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In shock waves with Mach numbers $M \lesssim M_{crit}$, strong electron heating is observed, indicating a suprathermal level of fluctuations. Collective scattering of laser light shows that, within the shock, ion wave fluctuations are up to a factor 10 above the thermal level, whereas electron waves are thermal. For $M > M_{crit}$, nonadiabatic ion heating takes place. (auth)

24578 MEASUREMENT OF SPECTRUM AND ANISOTROPY OF TURBULENCE WITHIN A COLLISIONLESS SHOCK BY SCATTERING OF LIGHT. Daughney, C. C.; Holmes, L. S.; Paul, J. W. M.; Summers, D. D. R. (Culham Lab., Abingdon, Eng.). pp 57 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Scattering of light from the shock reveals a spectrum of ion waves with highly random phases and a sharp cutoff for $k > 1/\lambda_D$. This turbulence is highly anisotropic about the direction of the driving electron current. The significance of these results for nonlinear kinetic theory is discussed. (auth)

24579 ELECTRON-TEMPERATURE MEASUREMENTS IN OBLIQUE AND NORMAL COLLISIONLESS SHOCKS IN MAGNETIZED PLASMAS. Sheffield, J.; Decker, G.; Macmahon, A. B.; Robson, A. E. (Univ. of Texas, Austin). pp 58 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Measurements are presented of the electron temperature behind shock waves in magnetized plasmas for Alfven Mach numbers in the range $M_A \simeq 2$ to 6 and at angles of 55 to 90° to the magnetic field. Below $M_A \simeq 2.5$ only the electrons are heated, while at higher M, an increasing fraction of the available energy goes to the ions. The results are compared with the predictions of a theoretical model. (auth)

24580 SHEATH FORMATION AND PLASMA HEATING IN LOW-DENSITY THETA PINCHES WITH ZERO INITIAL MAGNETIC FIELD. Dietz, K. J.; Hintz, E. (KFA-EURATOM, Juelich, Ger.). pp 60 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The fast magnetic compression of low-density plasmas was studied for various initial conditions. The radial field distributions at various times are shown. Electron-density populations ahead of the shock are discussed. Sheath formation and heating aspects are described. (M.O.W.)

24581 EXCITATION OF LANGMUIR OSCILLATIONS IN AN ION BEAM–PLASMA SYSTEM. Brakenhoff, G. J.; Houtkooper, J. M. (EURATOM–FOM, Amsterdam). pp 67 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The observation of spontaneously excited Langmuir waves with frequencies between ω_{pi} and ω_{pe} and with phase velocities a factor 2.5 to 4.1 higher than the ion beam velocity is reported. From the radial amplitude dependence of this wave it is identified as a Langmuir wave on a plasma column with the diameter of the ion beam. The mechanism to explain this excitation appears to be wave coupling in the end sheath of the Langmuir wave with the unstable slow ion beam wave and slow secondary electron beam wave. (auth)

24582 PLASMA OSCILLATIONS IN AN AXIAL INHOMOGENEOUS BEAM–PLASMA SYSTEM. Renner, H. (Univ., Munich). pp 70 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The negative glow of an abnormal glow discharged was studied to compare collective processes with binary collisions. The beam density is related to the relative axial plasma density. A hf probe indicated spatially growing oscillations along the axis. Diagrams of the oscillation spectra are given. (M.O.W.)

24583 COUPLING OF ELECTRON-CYCLOTRON HARMONIC WAVES WITH ELECTRON-BEAM INDUCED PLASMA WAVES NEAR THE UPPER HYBRID FREQUENCY. Clinckemaillie, A.; Piffl, V. (Institut fuer Plasmaphysik, Garching, Ger.). pp 72 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In several experimental works dealing with electron-beam–plasma interactions, the observations of energetic plasma electrons and the presence of high-frequency instabilities associated with the "cold-theory" plasma waves have been shown to be related in frequency ranges near the electron cyclotron harmonics. On the other hand it has been shown experimentally that noise-emission from a quasi-Maxwellian plasma is strongly enhanced near the electron cyclotron harmonics when a small electron beam is fired through the plasma; these results have been ascribed to the presence of longitudinal electron cyclotron harmonic plasma waves (Bernstein waves). Investigations reported here show that the wave phenomena quoted above can appear simultaneously and are in fact coupled with each other under the condition that the upper hybrid frequency is close to the second electron cyclotron harmonic. (auth)

24584 SHOCK WAVE GENERATED BY DISCHARGE PLASMA: APPROXIMATE DETERMINATION OF HOMOLOGICAL PARAMETERS. Rybowski L.; Renneboog, J. (Univ., Brussels). pp 75 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The Legendre representation of the experimental propagation law of a shock wave allows a fast and rather accurate calculation of the homological parameters. Results are given for different experimental conditions (gas, pressure, and discharge voltage). (auth)

24585 DESCRIPTION OF WAVES TO ALL ORDERS IN ELECTRON AND ION TEMPERATURES IN NONUNIFORM MAGNETIZED PLASMA. Monfort, J.-L.; Vandenplas, P. E. . (Ecole Royale Militaire, Brussels. Koninklijke Militaire School, Brussels). pp 99 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A general description of waves (with the differential equation for the electromagnetic field) in a nonuniform magnetized plasma is given to all orders in the T_e electron and T_i ion temperature and permits the complete treatment of a bounded plasma. The influence of T_e and T_i on the waves occurring in the magneto-ion domain (including the region around the lower hybrid frequency) is investigated. (auth)

24586 WAVE PENETRATION IN A MAGNETOACTIVE PLASMA. Moresco, M.; Zilli, E. (Univ., Padua). pp 128 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The anomalous penetration of an extraordinary wave in a magnetoactive plasma is studied. The effect of the ion motion is investigated in two cases: cold ions and hot ions with low collision frequency. The displacement current is not neglected in this analysis. (auth)

24587 PENETRATION OF A STRONG ELECTROMAGNETIC WAVE IN AN INHOMOGENEOUS PLASMA GENERATED BY ECR ON A MAGNETIC BEACH. Musil, J.; Zacek, F. (Inst. of Plasma Physics, Prague). pp 129 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The penetration of a strong right-hand circularly polarized electromagnetic wave in a dense inhomogeneous plasma, generated by electron cyclotron absorption of this wave on a magnetic beach was studied. The existence, movement, and overcoming of the evanescent region were proved. The experimental results are in good qualitative agreement with theory. (auth)

24588 REFLECTION AND DAMPING OF ELECTRON CYCLOTRON WAVES IN HIGH-DENSITY PLASMA. Bernabei, S. (CNR, Milan); De Dionigi, R.; Fontanesi, M.; Lisitano, G. pp 130 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Reflection measurements of an electron cyclotron wave propagating along a magnetic beach were made by means of a multi fringe interferometer. (auth)

24589 BEAM INSTABILITY, TRANSFORMATION, AND EIGENMODES IN AN INHOMOGENEOUS PLASMA. Kopecky, V. (Inst. of Plasma Physics, Prague). pp 132 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In a hot anisotropic plasma with an inhomogeneity across the magnetic field, eigenmodes are a superposition of long waves of cold plasma and short-wave Bernstein modes. As a consequence threshold currents of beam instability increase, as compared with the case of homogeneous plasma. (auth)

24590 EXPERIMENT ON THE EXCITATION OF BUCHSBAUM–HASEGAWA RESONANCES. Leuterer, F. (Institut fuer Plasmaphysik, Garching, Ger.). pp 133 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Results are presented for a steady-state experiment where the waves were excited by means of an externally applied hf capacitor field. A short microwave pulse was applied to the capacitor plates, and the transient plasma wave phenomena were observed with an antenna inside the plasma. Data for the various pulses recorded are given. (M.O.W.)

24591 LINEAR STABILITY OF EXPONENTIAL DENSITY PROFILES. Croci, R.; Saison, R. (Institut fuer Plasmaphysik, Garching, Ger.). pp 134 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The exact dispersion relation for a plasma with density profiles $n(x) \exp(-ax)$ in a homogeneous magnetic field $B = \frac{1}{2}B_0$ is derived. As an example, the low-frequency drift instability is considered . (auth)

24592 TEMPORAL LANDAU DAMPING OF ION WAVES IN ARGON PLASMA. Dzoanh, Nguyen T.; Rohde, Robert S. (Univ. of Notre Dame, Ind.). pp 137 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Temporal Landau damping of ion plasma waves was investigated experimentally by using standing waves that could be either self-excited or externally excited by an electric pulse. The experimental results agree very well with the theory of Fried and Gould, i.e., in a collisionless argon plasma, waves may decay exponentially by resonant absorption. The decay rate in time depends closely on the ratio of electron and ion temperature, as predicted by the theory. (auth)

24593 TEMPORAL ION-WAVE ECHOES IN A COLLISIONLESS ARGON PLASMA. Dzoanh, Nguyen T.; Rohde, Robert S. (Univ. of Notre Dame, Ind.). pp 138 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Recent experiments at the University of Notre Dame to verify the theory of Gould and O'Neil on the temporal evolution of plasma wave echoes are reported. Experimental results agree well with theory. Two standing ion waves are excited separately in time and

decay exponentially by the Landau process. A third wave (echo) spontaneously appears at a time predicted by the theory. The relationships between the amplitudes of the three waves are also satisfactorily checked. (auth)

24594 NONLINEAR ECHO PHENOMENA IN PLASMA. Sitenko, A. G. (Inst. for Theoretical Physics, Kiev). pp 139 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

High-frequency and low-frequency echo oscillations appearing in plasma from external perturbations are studied. Those resulting from the oscillation transformation are analyzed in detail. (auth)

24595 ELECTROSTATIC WAVES FOR PERIODIC INHOMOGENEOUS WATER-BAG AND TWO-STREAM MODELS. Bertrand, P.; Baumann, G.; Feix, M. R. (Univ., Nancy). pp 140 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

In a periodic inhomogeneous plasma, the concept of the dispersion relation $\omega(k)$ can be generalized into a relation $\omega(k,K)$ where K is the wavenumber of the periodic steady state. The solution in the two described models is easily obtained by introduction of a Lagrangian model. Results are presented, and it is shown that in the two-stream case, while the long wavelength has a smaller growth rate, an increased instability is found for $k/K = 1/2$. (auth)

24596 TRAPS FOR FAST MAGNETO-ACOUSTIC WAVES IN TRAPS FOR PLASMA. Deutsch, R. V.; Grosu, I.; Zoler, D. (Polytechnical Inst., Iasi). pp 141 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

It is shown that, in toroidal magnetic traps ring-like traps exist in which magneto-acoustic waves can be concentrated. The structure and fundamental properties of these domains for four particular models are discussed. (auth)

24597 PROPAGATION OF NANOSECOND WAVES ON PLASMA COLUMNS. Anicin, B. A. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 142 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Propagation of nanosecond wave packets in the axially symmetric TM mode on a positive column in mercury vapor is studied. The experimental setup is shown. The tube diameters are 12.00 and 15.4$_3$ mm, the glass is pyrex ($\epsilon_g = 4.8$) and the temperature of the mercury pool is controlled at 20°C. Waves are launched with a coaxial coupler to prevent excitation of modes with higher azimuthal variation. In reception, a similar coaxial coupler is connected to a sampling oscilloscope, the vertical and time outputs of which are linked to a chart recorder. A typical record of waveforms is shown. It is concluded that the launching and reception of a surface wave with couplers are strongly frequency-sensitive processes, with a prominent resonance at $\omega/\omega_p = 0.16$, which selects a narrow frequency band from the broad spectrum of the 3-nsec pulse. (M.O.W.)

24598 ELECTRON-TEMPERATURE OSCILLATIONS IN DRIFT WAVES AND THEIR EFFECT ON POTENTIAL MEASUREMENTS. Motley, R. W.; Ellis, R. F.; Jassby, D. L. (Princeton Univ., N. J.). pp 146 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Electron temperature oscillations in drift waves can greatly modify the relation between density and probe floating potential. Evidence for such effects in Q-machine plasmas is presented. (auth)

24599 NONLINEAR EFFECTS INVOLVING ELECTRON PLASMA WAVES. Franklin, R. N. (Oxford Univ.); Smith, G. J.; Hamberger, S. M.; Lampis, G. pp 158 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Observations are presented of the frequency spectrum in a plasma when large-amplitude electron plasma waves are excited. The spreading to side-band frequencies is shown, and the development of structure in the lower sideband detected. Parametric processes are also discussed. (auth)

24600 INTERACTION OF LOW-FREQUENCY WAVE WITH MICROTURBULENCE. Rogister, Andre (European Space Research Inst., Frascati, Italy). pp 159 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Kinetic theory was used to study the interaction of low-frequency, large-scale (compared to the ion Larmor radius R_i and frequency Ω_i) oscillations with high-frequency, short-wavelength ($\lambda \ll R_i$, $\omega \gg \Omega_i$) electrostatic microturbulence. In the general case, the relaxation of a weakly turbulent homogeneous plasma proceeds according to different time scales corresponding to different processes: quasi-linear relaxation of high-frequency oscillation buildup, nonlinear spectral energy transfer, and absorption of turbulent pulsations in plasmon–particle interactions. Two other time scales appear in the present problem: τ_{1f} corresponding to the low-frequency wave and τ_i corresponding to its interaction with the turbulence (plasmon–wave–plasmon interaction). (auth)

24601 TEST WAVES IN A TURBULENT PLASMA. Dum, Christian Thomas (Cornell Univ., Ithaca, N. Y.). pp 160 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The conductivity tensor of a turbulent plasma is computed from the coherent response of the plasma to an external test wave. Nonexpandable effects due to scattering of particles and modification of dielectric properties by the turbulent spectrum, which may become important, even at low levels of turbulence, are included. (auth)

24602 LAGRANGIAN DERIVATION OF WAVE–WAVE COUPLING COEFFICIENTS. Galloway, J. J.; Crawford, F. W. (Stanford Univ., Calif.). pp 161 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A Lagrangian technique is applied to the determination of plasma wave–wave coupling coefficients. It depends on space–time averaging of an expanded Lagrangian density, rather than the conventional iteration of the corresponding Euler equations, and is considerably more economical in effort. As an example, explicit results are given for three-wave coupling at arbitrary propagation angles in a cold infinite magnetoplasma. (auth)

24603 STOCHASTIC MODEL OF MODE-COUPLING THEORIES. Elsaesser, K.; Graeff, P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich. Institut fuer Plasmaphysik, Garching, Ger.). pp 162 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The hierarchy equations describing weakly interacting waves in a fluid are solved by the method of characteristic functionals combined with the time-asymptotic method of Krylov–Bogolyubov–Mitropolski. All fluid quantities look (in the stochastic sense) like solutions of a Langevin equation; they consist of a "friction" term into which the initial values (at $t = 0$) enter and a stochastically independent Gaussian noise (turned on at $t = 0$). (auth)

24604 POSSIBILITY OF PARAMETRIC RESONANCE IN ELECTRON PLASMA. Tsintsadze, N. L. (Inst. of Physics, Tbilisi, USSR). pp 164 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Electron plasma in a strong high frequency electric field is studied. It was shown that the electron mass oscillations in the external high-frequency field lead to parametric excitation of both potential and nonpotential high-frequency oscillations. (auth)

24605 OBSERVATION OF NONLINEAR LANDAU DAMPING OF ELECTRON PLASMA WAVES. Gentle, Kenneth W.; Malein, Anthony (Univ. of Texas, Austin). pp 166 of Fourth European

Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A nonlinear interaction between two electron plasma waves in a collisionless plasma was observed. A test wave at ω_1, k_1, is propagated in a plasma column, and damping or growth of this wave is measured in the presence of a second wave at ω_2, k_2 under conditions where the beat wave $\Delta\omega$, Δk does not satisfy the dispersion relation for any wave mode. (auth)

24606 INFLUENCE OF WAVE AMPLITUDE ON COLLISIONLESS DAMPING AT DIFFERENT PHASE VELCOITIES. Matitti, T.; Barbian, E. P.; Jurgens, B. (FOM-Instituut voor Atom- en Molecuulfysica, Amsterdam). pp 167 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The collisionless damping of electrostatic Langmuir waves was studied as a function of the wave amplitude. Two cases are distinguished: a) waves with such a phase velocity that the linear Landau damping is moderate; b) waves for which the linear Landau damping is strong. In the first case one observes a recovering of the wave at a certain distance from the exciting probe; in the second case the wave is definitely damped. (auth)

24607 RESONANT WAVE–PARTICLE INTERACTIONS IN AN ELECTROSTATIC PULSE IN AN INHOMOGENEOUS MEDIUM. Nunn, D. (Imperial Coll. of Science and Tech., London). pp 170 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The resonant-beam excitation of a wave pulse whose wave number is spatially varying is considered. After one trapping period, stably trapped second-order resonant particles are dominant and give rise to very large growth rates and to a steady change in the frequency and wave number of the pulse. (auth)

24608 MODULATED SOLITARY WAVES PROPAGATING IN A THREE-COMPONENT PLASMA IN A MAGNETIC FIELD. Lominadze, D. G.; Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). pp 174 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Modulated waves compression solitary are considered in a three-component plasma containing negatively charged ions when the electron inertia may be neglected. Numerical calculations to determine characteristic magnitudes of plasma were carried out on a computer. (auth)

24609 PROPAGATION OF SOLITARY WAVES OF SMALL AMPLITUDE IN A COLLISIONLESS PLASMA. Orefice, A.; Pozzoli, R. (Istituto di Fisica, Milan). pp 175 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

A generalized Kortweg-de Vries equation is derived for nonlinear drift waves propagating with a nonzero angle with respect to the external uniform magnetic field. A relation is presented between amplitude and propagation velocity of solitary drift waves. (auth)

24610 PHASE-LOCKING OF COUPLED MODES IN NONLINEARLY UNSTABLE PLASMAS. Wilhelmsson, H.; Oestberg, W. (Inst. of Physics, Uppsala). pp 176 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

Phase locking of three coupled modes for plasma systems that are explosively unstable is discussed. The study is carried out within the framework of the well-defined phase description. It turns out that appreciable phase locking occurs in a period of time shorter than the time the explosive instability needs to develop. (auth)

24611 LINEAR WAVES IN INCOMPRESSIBLE BEAM–PLASMA SYSTEMS. Verheest, Frank (State Univ., Ghent). pp 186 of Fourth European Conference on Controlled Fusion and Plasma Physics. Rome; Comitato Nazionale per l'Energia Nucleare (1970).

From fourth European conference on controlled fusion and plasma physics; Rome, Italy (31 Aug 1970). See CONF-700817.

The dispersion law for linear waves in incompressible beam–plasma systems is derived. Several special cases are discussed. (auth)

24612 CORRELATION PATTERNS FOR AN ELECTROMAGNETIC FIELD INTERACTING WITH A RELATIVISTIC PLASMA. Balescu, R. (Univ. Libre, Brussels. Univ. of Texas, Austin); Paiva-Veretennicoff, I. Bull. Cl. Sci., Acad. Roy. Belg.; 57: 457-76(1971).

A statistical description of a relativistic plasma whose particles interact through an electromagnetic field is constructed in terms of reduced distribution functions and correlation patterns. Explicit expressions are given for the generalized Liouville operators generating the infinitesimal transformations of the Poincaré group. Also, a clear and general definition is given of the vacuum and correlation projectors, thus opening the way to an explicit nonequilibrium statistical mechanics of these systems. A particular aspect of this work relates to the treatment of the electromagnetic field in terms of reduced distributions. It thus provides a model for proper handling of continuum systems. (auth)

24613 ELECTROMAGNETIC EXCITATION WITH POLARIZATION OPPOSITE TO THE HELICON IN AN UNCOMPENSATED MAGNETOACTIVE PLASMA. Protogenov, A. P.; Demikhovskii, V. Ya. (Gorky State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 9, 356-9(5 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 9, 518-22(5 Nov 1971).

It is shown that a collective excitation with polarization opposite to that of the helicon and with a frequency smaller than Ω propagates in an uncompensated electron–hole solid-state plasma. Its dispersion equation is solved, and the cases of different wave vectors and angles are considered. The influence of the excitation on the surface impedance and wave distribution in a metal is examined. The spectrum of the wave is discussed briefly. (D.L.C.)

24614 PROPAGATION OF SMALL PERTURBATIONS IN A ROTATING PLASMA WHEN THE HALL EFFECT IS CONSIDERED. Mattei, G. Rend. Semin. Mat. Univ. Padova; 43: 349-61(1970). (In Italian).

For a uniformly rotating compressible plasma, the propagation of small plane perturbations was studied, taking account of the Hall effect. The plasma is assumed nonviscous and a perfect conductor of electricity. The electric conductivity is assumed to be finite. In both cases, propagation both normal and parallel to the axis of rotation is considered. (App. Mech. Rev.)

24615 WAVE PROPAGATION IN A STRATIFIED MULTIFLUID PLASMA. Daniele, V. (Politecnico, Turin). Alta Freq.; 40: No. 11, 904-14(Nov 1971).

The transverse field equations in an anisotropic multifluid plasma are obtained. The Green's function is then introduced and its double Fourier transform is evaluated in transversely homogeneous media by using a general technique that is useful in both continuous and discontinuous stratified media. The plane wave propagation can be considered as a particular case of this evaluation. (auth)

24616 PROPAGATION OF STRONG-FIELD MODULATED ELECTROMAGNETIC WAVES IN PLASMAS. Bachynski, M. P.; Gibbs, B. W. (RCA Labs., Montreal). Can. J. Phys.; 49: No. 24, 3208-20(15 Dec 1971).

The distortion of the wave form of a modulated plane electromagnetic wave propagating in an anisotropic plasma was experimentally investigated over a range of field strengths of the wave and plasma properties. By using right-hand circularly polarized waves, the effective frequency is $|\omega - \omega_b|$ (where ω is the rf radian frequency and ω_b the cyclotron frequency) and hence the results are also applicable to the propagation of low-frequency waves in an isotropic plasma. Severe "overmodulation" of the wave form transmitted through the plasma is found in the regime $|\omega - \omega_b|/\nu < 1$, where ν is the effective collision frequency for momentum transfer. The distortion of the wave form is found to increase with depth of modulation of the incident wave and decrease with increasing modulation frequency. The "demodulation" is in qualitative agreement with theory for an unmodulated wave with a non-Maxwellian (Druyvesteyn) velocity distribution for the electrons. Many of the effects of the modulation frequencies can also be qualitatively predicted by considering the variation of electron temperature in the presence of the strong-field modulated wave. A theory developed for large changes in electron temperature induced by the incident field shows that marked distortion of the modulation is possible. (auth)

24617 EXCITATION OF ELECTROSTATIC FIELDS IN A PLASMA BY TRANSVERSE ELECTROMAGNETIC WAVES.

Bachynski, M. P.; Gibbs, B. W. (RCA Labs., Montreal). Can. J. Phys.; 49: No. 24, 3221-6(15 Dec 1971).

An experiment was conducted in which a plane transverse electromagnetic wave is incident from free space on a layer of isotropic plasma at small angles (0 to 12°) of incidence. Strong longitudinal electrostatic fields are observed within the plasma in the regions where the frequency of the incident wave equals the plasma frequency when the electric vector of the incident wave is in the plane of incidence. Only weak longitudinal electrostatic fields are observed if the electric field of the incident wave is perpendicular to the plane of incidence. The observed phenomenon appears consistent with the field growth in a region where the dielectric coefficient of a plasma becomes a zero. (auth)

24618 HYBRID RESONANCES IN NONHOMOGENEOUS MAGNETO-ACTIVE PLASMA. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Establishment, Cairo). Physica; 58: No. 1, 144-60(1 Mar 1972).

Nonlinear longitudinal oscillations excited by an external traveling-wave high-frequency field in a nonhomogeneous plasma are investigated theoretically. The amplitude of oscillations of charged particles in the plasma is shown to infinitely increase when the external-field frequency approaches one of the natural (hybrid) plasma frequencies. The increase in the amplitude is limited in principle by nonlinear terms involved in the equations of motion and dictated by the inhomogeneity of plasma density. However, motion of the plasma particles turns out to be multiflux long before the limitation is imposed on the amplitude of the oscillations. The multiflux motion is unstable so that within a wide range next to the hybrid-resonance points the plasma oscillates turbulently. Since the energy of the turbulent pulsations is sustained by external forces, the energy of the high-frequency field can be strongly absorbed, which leads to an effective heating of the plasma. (auth)

24619 HIGH-AMPLITUDE WAVES IN THE PLANE LAYER OF A MAGNETO-ACTIVE PLASMA. Demchenko, V. V.; Hussein, A. M. (Atomic Energy Establishment, Cairo). Physica; 58: No. 1, 161-4(1 Mar 1972).

The effect of high-frequency potential on the propagation of high-amplitude TM waves in the plane layer of a magnetoactive plasma is investigated. A dispersion equation that differs essentially from the linear dispersion equation is obtained. The particle density distribution over the layer cross section is also found. (auth)

24620 OSCILLATIONS OF AN INHOMOGENEOUS BOUNDED PLASMA. Ray, Tushar (Panskura B. Coll., India). Indian J. Phys.; 44: No. 8, 457-62(Aug 1970).

Quasi-static waves on a plasma cylinder with radially varying density were studied. An approximate dispersion relation is derived, with the use of a dielectric tensor which is a local quantity, and is compared with the case of a homogeneous plasma cylinder. (auth)

24621 DIRECT NONLINEAR COUPLING OF ELECTROMAGNETIC WAVES AND ELECTROSTATIC WAVES IN A PLASMA. Phelps, David Allen. Irvine, Calif.; Univ. of California (1971). 160p. University Microfilms Order No. 72-2250.

Thesis.

The direct nonlinear coupling among small-amplitude electromagnetic and electrostatic waves in the bulk volume of a plasma is analyzed theoretically and was observed experimentally. The experimental configuration consisted of a cyclindrical waveguide partially filled with a Q-machine plasma column. The electromagnetic waves are related to the well-known TM and TE waveguide modes. The electrostatic waves are the electron –plasma body waves first studied by Trivelpiece, and the long-wavelength ion–acoustic plane waves. Assumptions that the plasma column is warm and drifting enable the various wave types to be described in terms of a single dispersion relation. With the fundamental properties of the physical model understood in theory and experiment, the theory is then alternately expressed in terms of Hamiltonian mechanics, and shown to satisfy the action-transfer and phase-shift relations of Sturrock. The theory is then extended to include the analytically important interactions among random fluctuations in a weakly turbulent plasma. Certain nonlinear plasma instabilities, such as the "collisions" of high-energy plasmons with plasmons and photons, which can enhance photon emission (plasma cooling), and/or ion fluctuations (plasma heating, diffusion), are thus indirectly supported by observations of stimulated and ordered fundamental processes in plasma waveguides. (TSS) (Diss. Abstr. Int., B)

24622 PROPAGATION OF WAVES PERPENDICULAR TO THE MAGNETIC FIELD IN A TWO-COMPONENT WARM PLASMA. Sharma, S. R.; Bhatnagar, T. N. (Univ. of Rajasthan, Jaipur, India). J. Phys., A (London); 5: No. 3, 471-8(Mar 1972).

Propagation of small-amplitude waves perpendicular to the magnetic field in a two-component magnetoactive, unbounded warm plasma having arbitrary mass ratio was examined using Maxwell's equations for the electromagnetic field and the first three moment equations for each component. The full-pressure tensor equation (neglecting the heat flow tensor) was used and the effect of momentum and pressure relaxation mechanisms was included in the analysis. Dispersion relations for pure transverse waves were obtained and are discussed in detail for both low- and high-frequency propagation. The effect of thermal motions and collisions was examined for transverse and coupled waves. It was found that the pressure relaxation mechanism contributes significantly in the damping of oscillations at the harmonic cyclotron frequency. (auth)

24623 PARAMETRIC EXCITATIONS OF ION PLASMA OSCILLATIONS. Kozima, Hideo; Yamagiwa, Keiichiro; Amagishi, Yoshimitsu; Kato, Kiyoe (Shizuoka Univ., Japan). J. Phys. Soc. Jap.; 32: No. 4, 1102-5(Apr 1972).

Parametric excitations of ion plasma oscillations are investigated by using a simple model based on the modulation of ion density in the uniform electron background. This model is useful to calculate the higher-order nonlinear terms and gives a good interpretation to the new nonlinear phenomena observed in a mercury vapor plasma without magnetic field. The nonlinear effects observed are: (1) frequency shift and amplitude increase of the resonant oscillations with increasing of pumping power, (2) existence of the resonance frequency region, and (3) the asymmetric parametric excitation with hysteresis. (auth)

24624 COLLISIONLESS QUASI-SHOCK WAVE IN A LONGITUDINAL MAGNETIC FIELD. Abe, Kanji; Niu, Keishiro (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 32: No. 4, 1121-4(Apr 1972).

Numerical studies of steady, one-dimensional, quasi-shock waves in a collisionless plasma are made for the case where the shock waves are propagating along a uniform magnetic field. It is supposed that the flows of ions and electrons ahead of the shock wave consist of two cold streams, respectively, which have different velocities from each other. Numerical computations are carried out using fluid equations for the streams and Maxwell's equations for the electromagnetic field. Behind the wave front the plasma and magnetic field oscillate rather irregularly about mean values, which are different from the values ahead of the wave front. (auth)

24625 PROPAGATION OF FAST MAGNETO-ACOUSTIC WAVES IN THE FIELD OF A MONOPOLE. Deutsch, R. V.; Laur, F. Bul. Inst. Politeh. Iasi; 15: No. 3-4, 89-94(1969). (In French).

Transmission of waves in a homogeneous plasma is studied in the presence of a spherically symmetric magnetic field for which the only nonzero component is radial and inversely proportional to the distance from a monopole. The cases examined are those near and far from the monopole, for which the Alfven speed is greatly different from the acoustic speed. The techniques of geometrical optics are employed for the solution developed by use of Hamilton–Jacobi equations, and "ray" diagrams are presented for the two cases. (Appl. Mech. Rev.)

24626 ROLE OF COLLISION IN ION ACOUSTIC WAVES. Paranjape, B. V.; Sharma, S. K. (Univ. of Alberta, Edmonton). Phys. Lett.; 38A: No. 7, 481-2(27 Mar 1972).

Influence of collisions is considered in a nearly collision-free plasma. It is found that the phase velocity of ion acoustic waves increases when their wave length becomes comparable with the mean free path of the electrons. (auth)

24627 SELF-CONSISTENT THEORY OF A COLLISIONLESS RESISTIVE SHOCK. Manheimer, Wallace M.; Boris, Jay P. (Naval Research Lab., Washington, D. C. Phys. Rev. Lett.; 28: No. 11, 659-62(13 Mar 1972).

A self-consistent collisionless theory is presented for turbulent, low-Mach-number resistive shocks. Both analytic predictions of shock structure and more detailed numerical solutions are in excellent agreement with experimental observations. (auth)

24628 HIGH-ORDER WAVE MIXING IN BEAM–PLASMA INSTABILITIES. Carr, W.; Boyd, D.; Liu, H.; Schmidt, G.; Seidl, M. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev. Lett.; 28: No. 11, 662-5(13 Mar 1972).

When two waves, ω_1 and $\omega_1 + \Delta\omega$, are externally driven in an unstable beam–plasma system, they are found to couple in the nonlinear regime to produce up to ten waves, with frequencies

given by $\omega_1 \pm n\Delta\omega$ and amplitudes comparable to the driver amplitudes. This situation is described in terms of third- and higher-order wave-interaction processes. It is suggested that this phenomenon is responsible for nonlinear broadening of the amplified noise spectrum. (auth)

24629 ELECTROSTATIC ION-ACOUSTIC SHOCKS PRODUCED BY DENSITY STEPS. Cohn, D. B.; MacKenzie, K. R. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 28: No. 11, 656-8(13 Mar 1972).

Large-amplitude ion-acoustic shocks are produced by superposition of a pulsed photo-ionized plasma slab on a dc background. The Mach number M increases as a function of the step ratio R up to a maximum of $M \approx 2.5$ for $R = 20$. Above $R = 5$ and a shock jump of $\Delta n/n \approx 1$, the shock widths start to broaden severely with distance from the source. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 23677, 24668, 24691, 24700, 24714, and 25031.

24630 (AD-731709) IONIZATION IN MICROSCOPIC VOLUMES IRRADIATED BY ENERGETIC PHOTONS. Final Report. Braby, Leslie A.; Ellett, William H. (Oregon State Univ., Corvallis. Radiation Center). 10 Oct 1971. Contract N00014-67-A-0369-0006. 166p. NTIS.

The energy absorbed by microscopic volumes exposed to ionizing radiation is not well represented by the average dose due to the small number of discrete energy transfers involved. The energy deposited in a microscopic volume can be determined by measuring the ionization in a detector filled with gas at low pressure. A grid-walled spherical proportional counter suitable for making such measurements for photon irradiation is described and compared to a solid-walled counter. Measured ionization distributions are presented for ^{60}Co gamma irradiation, filtered and unfiltered 250-kVp x rays, and for 65-kVp x rays. Other distributions that may be of use in understanding radiation damage models are calculated from these measured distributions. (auth) (USGRDR)

24631 (EGG-1183-1519) MONTE CARLO CALCULATION OF ELECTRON PRODUCTION BY A GAMMA BEAM INCIDENT ON A THICK FOIL. Technical Report No. L-1032. Wecksung, G. W.; Walker, J. J.; Brown, R. T. (EG and G, Inc., Las Vegas, Nev.). 20 May 1971. 22p. Dep. NTIS.

Monte Carlo methods were applied to the study of the production of an electron current by a high-energy photon beam traversing a thick foil. Both Compton scattering and the photoelectric effect are considered. Calculated sensitivities of Al and Fe as a function of thickness agree with experimental measurements to within a few percent. (auth)

24632 (LA-DC-13269) MULTIGROUP MONTE CARLO AND S_n METHODS FOR AIR TRANSPORT. Harris, D. R.; Koenig, D. R.; Preeg, W. (Los Alamos Scientific Lab., N. Mex.). 15 Nov 1971. 20p. (CONF-711125-8). Dep. NTIS.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

Calculations of radiation transport through air and other materials frequently utilize multigroup codes, particularly S_n codes, but also Monte Carlo codes. A series of multigroup codes and methods are tested here for neutron transport in air by comparison of calculations against Livermore time-of-flight measurements of neutrons emerging from liquid nitrogen and liquid oxygen spheres pulsed by D-T neutrons. These experiments are most readily analyzed by Monte Carlo techniques, so the analysis proceeds in two steps. First, it is established theoretically and verified by test cases, including an air transport milestone case, that the series of multigroup S_n codes agree with the ANDY multigroup Monte Carlo code. Second, the ANDY code is used to calculate the Livermore nitrogen and oxygen experiments for various multigroup structures and scattering treatments based on the latest Young-Foster evaluations of nitrogen and oxygen cross sections. The results indicate that comparison with these pulsed sphere experiments is insensitive to group structure and scattering pattern, and that reasonable agreement can be obtained with P_0 transport corrected cross sections having only 10 energy groups above the detector energy bias. (auth)

24633 (ORNL-TM-3678) MONTE CARLO CALCULATIONS OF THE DOSE INDUCED BY CHARGED PIONS AND COMPARISON WITH EXPERIMENT. Armstrong, T. W.; Chandler, K. C. (Oak Ridge National Lab., Tenn.). 4 Feb 1972. 31p. Dep. NTIS.

A calculational method that utilizes Monte Carlo techniques in conjunction with the intranuclear-cascade-evaporation model for treating nuclear interactions is applied to study the dose induced in matter by charged pions. To test the validity of the calculational method for pion dose calculations, calculated results are compared with experimental data for the absorbed dose induced in water phantoms by a π^- beam of mean momentum 175 MeV/c and by π^- and π^+ beams of mean momentum 150 MeV/c. The calculated and experimental results are in good general agreement, but the comparisons are not completely definitive because precise descriptions of the incident beams used in the experiments are not available. The calculations indicate the importance of secondary particles in determining the spatial dependence of the absorbed dose and dose equivalent. Information on the spatial dependence of the neutron current produced by the 175-MeV/c π^- beam is also calculated. (auth)

24634 EMPIRICAL RELATIONS FOR ABSORPTION OF LOW-ENERGY POSITRONS AND ELECTRONS IN METALS. Rupaal, A. S.; Patrick, J. R. (Western Washington State Coll., Bellingham). Phys. Lett.; 38A: No. 6, 387-8(13 Mar 1972).

The absorption of low-energy positrons and electrons in metals is found to be Z-dependent and obeys an empirical relation of the form $t = K \exp(mZ^b)$. Experimental results are used to obtain values of m for positrons and electrons. (auth)

24635 PARTICLE TRANSPORT IN SPHERICAL MEDIA WITH A CENTRAL BLACK CAVITY. Sheaks, O. J. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.); 13: No. 2, 203-9(Feb 1972).

A transform procedure is applied to the integral form of the Boltzmann transport equation to obtain the particle density in a spherically symmetric medium surrounding a central black absorber. The singular eigenfunction expansion technique is applied to provide a general solution, and boundary conditions are derived for the general equation for arbitrary multiplication and source distributions. Specific applications to the spherical Milne problem and a uniform source distribution are presented to demonstrate the application of the general transform technique. (auth)

24636 ENERGY DISTRIBUTION OF TRANSMITTED SECONDARY ELECTRONS FROM POROUS KCl FILMS. Akagi, M.; Yoshida, S. (Tohoku Univ., Sendai). J. Appl. Phys.; 43: No. 3, 880-5(Mar 1972).

Energy distribution of secondary electrons from three types of porous films (porous KCl films, porous KCl films with intermediate thin Al layer, porous KCl films containing small amount of amorphous Al) was measured by an ac retarding-field method. The half-width of each energy distribution curve was found to be about 10 to 20 eV. The surface potential of these films was also obtained from the rising point of the energy distribution curve. A single relationship between surface potential and yield and independent of collector voltage was found for constant primary energy. Decay characteristics of the surface potential of three films after ceasing the primary electron bombardment were similar to each other. Secondary currents from a porous KCl film containing a small amount of amorphous Al were found to be considerably more stable compared to those from two other films. A secondary electron emission is proposed using a channel electron multiplier model. (auth)

24637 INELASTIC ENERGY LOSSES IN GASES AND ELECTRONIC STOPPING POWERS IN SOLIDS. Bierman, D. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam); Van Vliet, D. Physica; 57: No. 2, 221-36(15 Jan 1972).

Inelastic energy-loss values were measured from gas-phase collisions and are applied to derive values of the electronic stopping powers in solids using a computer simulation model. The specific cases investigated were 19.4-keV Ne^+ in copper, 21.0 keV Ne^+ in nickel, and 45.5 keV Ne^+ in aluminum, both for random incidence and for perfect alignment along ⟨001⟩ or ⟨101⟩. These exploratory results indicate that the method is capable of providing realistic stopping-power values and, while probably less accurate than conventional techniques, should allow one to experimentally investigate the Z_1 and Z_2 oscillations in the stopping power and the transition in the stopping power from a channeled to a random trajectory from the point of view of single collisions. The computer model was also used to calculate penetration profiles for the above systems and allows one to study the relative energy deposition by both nuclear and electronic collisions. A funneling effect by which channeled orbits are consistently forced toward the center of the channels was observed in the ⟨101⟩ channels and leads to well-defined maximum ranges. (auth)

24638 MULTIPLE COHERENT BREMSSTRAHLUNG OF ELECTRONS IN CRYSTALS. Ferretti, B. (Univ., Bologna. CERN, Geneva). Nuovo Cim.; 7B: No. 2, 225-39(11 Feb 1972).

It is recalled that the Born approximation might become grossly insufficient for calculating the bremsstrahlung of electrons in crystals when the energy of the incoming electron is sufficiently high. Therefore, a method was devised for calculating multiple coherent bremsstrahlung in crystals making use of the coherent state of the radiation. The method is valid when pair creation is negligible and, therefore, when the energy of the photon is very small as compared to the energy of the electron. An asymptotic solution of the equations of motion is given and discussed. The solution is valid for positrons and not for electrons. (auth)

24639 SEMI-EMPIRICAL APPROACH FOR FISSION FRAGMENT ENERGY DEGRADATION IN ANY ELEMENTARY MEDIUM. Hakim, M.; Shafrir, N. H. (Technion-Israel Inst. of Tech., Haifa). Can. J. Phys.; 49: No. 23, 3036-40(1 Dec 1971).

A semi-empirical equation for the electronic energy loss of fission fragments was derived by fitting the theoretical approach of Bohr, specifically developed for heavy stopping materials, to experimental data in gases and solids in a wide range of atomic numbers. The fitting procedure was performed by choosing a different expression for the number of electrons of the medium taking part in the stopping process, which includes empirical parameters obtained by fitting to experiment. The equation enables the energy loss of fission fragments in substances of any Z_2, regardless of their physical state, to be predicted to a good degree of accuracy down to energies of approximately 20 MeV. (auth)

24640 ^{252}Cf FISSION FRAGMENT ENERGY LOSS MEASUREMENTS IN ELEMENTARY GASES AND SOLIDS AS COMPARED WITH THEORY. Hakim, M.; Shafrir, N. H. (Technion-Israel Inst. of Tech., Haifa). Can. J. Phys.; 49: No. 23, 3024-35 (1 Dec 1971).

Energy loss of ^{252}Cf fission fragments in 15 gases and solids, representing a wide range of atomic numbers throughout the periodic system, was measured using a calibrated Si surface barrier heavy ion detector. The data are used for a detailed and systematic comparison with existing theoretical treatments of the electronic energy loss mechanism showing that none of them gives overall good agreement for all stopping substances. The Bohr expression for heavy stopping substances, which shows consistent deviation from experiment for the entire range of stopping media, suggests that based on this approach, a semi-empirical modification can be derived. (auth)

24641 REFLECTION OF keV HEAVY-ION BEAMS FROM SOLID TARGETS. DEPENDENCE ON ENERGY AND ANGLE OF INCIDENCE. Boettiger, J.; Joergensen, H. Wolder; Winterbon, K. B. (Univ. of Aarhus, Denmark). Radiat. Eff.; 11: No. 3-4, 133-8(Dec 1971).

Recent experimental and theoretical studies of the reflection of keV heavy-ion beams were extended to higher energies and to nonperpendicular incidence. The reflection coefficient for Na^+ and K^+ ions backscattered from polycrystalline gold and silver targets was determined for perpendicular incidence at energies of 100 to 500 keV. The dependence on angle of incidence was investigated at 30 keV for the same combinations of targets and projectiles. Effects of electronic stopping were included in the theoretical calculations. Good agreement between the experimental results and the theoretical calculations was found. (auth)

24642 INTERACTION OF 3.9-GeV NITROGEN IONS WITH MATTER. Schimmerling, Walter (Princeton Univ., N. J.); Vosburgh, Kirby G.; Todd, Paul W. Science; 174: No. 4014, 1123-5(10 Dec 1971).

The interaction with matter of nitrogen ions in the 3.9-GeV beam of the Princeton Particle Accelerator was studied. In polyethylene, the range of ions is 12.6 ± 0.2 g/cm^2, and the mean free path for nuclear collisions is 15.4 ± 3.8 cm; the loss of energy by the ions passing through polyethylene agrees with that predicted by stopping-power theory. The production of secondary particles was investigated. These data are useful for experiments and for evaluating the merits of nitrogen ions in biomedical applications. (15 figures, 1 table) (auth)

24643 APPROXIMATION OF SINGLE SCATTERING IN THE CALCULATION OF THE EXPOSURE INTENSITY DUE TO THE BACKSCATTERING OF GAMMA RAYS. Bottino, A.; Zampini, F. (CNEN, Rome). Minerva Fisiconucl.; 15: No. 1, 1-14(Jan-Mar 1971). (In Italian).

Determination of the exposure intensity due to the backscattering of γ rays constitutes a problem that is frequently encountered in the framework of health protection. The nature of the phenomenon of backscattering is such that there is no possibility of a solution which is both general and easily applicable. Because of the need of such a solution, the limits in which the phenomenon can be described by a solution that presents the single scattering approximation are defined. (tr-auth)

24644 Z_1^3 EFFECT IN THE STOPPING POWER OF MATTER FOR CHARGED PARTICLES. Ashley, J. C. (Oak Ridge National Lab., Tenn.); Ritchie, R. H.; Brandt, Werner. Phys. Rev., B; 5: No. 7, 2393-7(1 Apr 1972).

A classical formulation is considered for the interaction of a particle of charge Z_1e incident at a given impact parameter with an electron bound isotropically and harmonically to the origin with a frequency ω. From a perturbation expansion that assumes that the displacement of the bound electron is small compared to the impact parameter, and integrating over the impact parameter from some minimum value to infinity, an expression for the stopping power is found. The leading term in this expansion is proportional to $(Z_1e^2)^2$ and is the usual result for this type of model, while the second term gives us the $(Z_1e^2)^3$ correction. The Z_1^3 correction for the Lenz–Jensen statistical model for the atom is presented. The predictions of this theory are in excellent agreement with available experimental data. (auth)

24645 ROENTGEN- UND KERNPHYSIK FUER MEDIZINER UND BIOPHYSIKER. (Radiation and Nuclear Physics for Physicians and Biophysicists). Glocker, Richard; Macherauch, Eckard. Stuttgart; Georg Thieme Verlag (1971). 529p. DM 44,80.

Treated are radiation and matter, nuclear reactions and radioactivity, production and properties of corpuscular radiation, and production and property of x radiation. Subsequently discussed are radiation effects and radiation measurements, dosimetry, and radiation protection. One special chapter is devoted to diagnostic and therapeutic applications of x rays. The concluding section discusses the application of radioisotopes in medicine and biology. (H.B.G.)

24646 RESONANCE BEHAVIOR IN THE ANGULAR DISTRIBUTION OF THE TRANSITION RADIATION NEAR THE PLASMA FREQUENCY. Binias, G.; Kuhnert, K. (Univ., Hamburg). Phys. Lett.; 38A: No. 7, 467-8(27 Mar 1972).

The angular distribution of the intensity of the transition radiation has a maximum at a certain angle (θ_{max}). The dependence of θ_{max} on thin silver films was measured as function of the wave length of the emitted radiation. It was found that the value of θ_{max} passes through a deep minimum at the plasma frequency (λ_p = 3280 Å). (auth)

24647 SELF-ABSORPTION OF GAMMA RAYS PRODUCED IN LARGE CYLINDRICAL SAMPLES. Dickens, J. K. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 98: No. 3, 451-4(1972).

An exact expression is derived for the self-absorption of gamma rays produced uniformly throughout large cylindrical samples (i.e., diameter > 1 mean-free path). The calculated self-absorption of gamma rays emitted by ^{110m}Ag is compared with observed absorption by a 2-cm-diameter Pb sample. Calculated self-absorption of gamma rays produced by 7-MeV neutron interaction with ^{208}Pb agrees with estimates based upon Monte Carlo computations. (auth)

24648 PION STOPPING REGION VISUALIZATION EXPERIMENTS. Dean, P. N.; Holm, D. M. (Los Alamos Scientific Lab., N. Mex.). Radiat. Res.; 48: No. 2, 201-5(Nov 1971).

Negative pi mesons have been proposed as a modality for tumor therapy. They have many possible advantages over other modalities. One of these is the possibility of in situ monitoring of the treatment volume. Three methods of doing this have been proposed. Two of the methods involve nuclear γ-rays and the production of positron emitters. Preliminary experiments designed to test the concepts involved in these methods have been reported. The results of an experiment to test the third method are reported here. A beam of π^- mesons was stopped in water, and the mesic x-rays were detected with a position-sensitive detector (Anger camera). All three methods are discussed. (auth)

24649 EFFECT OF AIR GAP ON ABSORBED DOSE IN TISSUE. Scrimger, J. W. (W. W. Cross Cancer Inst., Edmonton, Alberta). Radiology; 102: No. 1, 171-2(Jan 1972).

The effect of air spaces on absorbed dose was studied using thermoluminescent dosimeters (TLD). It was determined that, for ^{60}Co gamma rays, distances of 12 cm or more from the scattering materials were adequate to preserve skin sparing. Also, internal body cavities with dimensions greater than 4 cm in the direction of the beam would experience a reduced dose on the distal surface of the cavities. (auth)

24650 DEPTH DOSE AND SCATTER ANALYSIS OF 10 MV X RAYS. Khan, Faiz M.; Moore, Vaughn C.; Sato, Shyuichi (Univ. of Minnesota, Minneapolis). Radiology; 102: No. 1, 165-9 (Jan 1972).

Central axis depth doses for 10 MV x rays from the Toshiba linear accelerator were measured in a water phantom using ionization chambers. Measurements of dose in the buildup region were made with thin layers of LiF powder in a polystyrene phantom. The data were analyzed by a computer program to generate tables of percent depth doses, tissue-maximum ratios, and scatter phantom ratios. (auth)

Radiation Protection Standards

24651 (NP-19227) LEGISLATION IN THE FIELD OF RADIATION PROTECTION. (European Communities, [Brussels] (Belgium). Commission). Oct 1971. 160p. (In several languages). Dep. NTIS (U. S. Sales Only).

A summary is given of the legislative, regulatory, and administrative orders with respect to radioprotection, in force in the member states of the European Community by virtue of directives establishing the fundamental standards of Euratom. (tr-auth)

Radiation Source Calibration and Standardization

Refer also to abstract 25033.

24652 NEUTRON SPECTRUM FROM THE 4.43 MeV LEVEL OF THE ^{12}C IN A Po-Be SOURCE. Del Fabbro, R.; Matone, G.; Roccella, M. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 3: No. 5, 206-10(29 Jan 1972).

The neutron spectrum of a Po-Be source was measured by means of the time-of-flight technique. Start time was given by the 4.43-MeV gamma ray from ^{12}C. The neutron spectrum from 1 to 7 MeV is shown. The contribution of secondary processes in the source was evaluated and found to be roughly in agreement with experiment. (3 figures) (R.W.R.)

Shielding Calculations and Theory

Refer also to abstracts 23940, 24208, and 24766.

24653 (ZJE-109) GROUP CONSTANTS FOR A SOLUTION OF NEUTRON PENETRATION PROBLEMS IN SHIELDS. Valenta, V.; Komorous, V. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 89p. Dep. NTIS (U. S. Sales Only).

Instructions and basic data are presented for the construction of group constants necessary for a solution of the transport equation of neutrons. The influence of resonances in a finite medium is considered. (auth)

24654 NEW METHOD FOR REDUCTION OF FLUX MOMENTS WITH THE P_N APPROXIMATION. Haring, Guenter (Technische Hochschule, Graz). Acta Phys. Austr.; 32: No. 3-4, 357-62(Mar 1970). (In German).

Solution of the Boltzmann equation by approximation is discussed. Davison's elimination procedure for reduction of the differential equations becomes practically infeasible for determination of flux moments in complex systems or for higher degrees of approximation. Under these conditions, an algebraic procedure appears more useful. Such a procedure is outlined, whereby the differential equations are transformed stepwise into a desirable system. Results are discussed for a case of one-dimensional cylindrical geometry. (H.B.G.)

24655 RADIATION HAZARDS AND SHIELDING. Mehta, S. S.; Johri, S. S. (Jodhpur Univ., India). Indian Eng.; 14: No. 9, 1-8(Sep 1970).

Various biological effects of radiation clouds formed as a result of an accident in a reactor are pointed out. Tables showing the maximum permissible dose for a normal person are given. Various available radiation shielding methods are described. The suitability of shielding materials is discussed under three broad categories, namely, heavy elements, hydrogenous materials, and boron compounds. (INIS)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 22824, 23389, and 23392.

24656 (EURFNR-946) DEFECT PRODUCTION RATES AND DISPLACEMENT CROSS SECTIONS IN METALS AND ALLOYS UPON IRRADIATION IN REACTORS AND ACCELERATORS. Ehrlich, K.; Kaletta, D.; Schneider, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-1438. 27p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

Defect production rates due to nuclear interaction between bombarding and target atom were calculated for the case of neutron with the hard-sphere-model and for the case of charged particles (α, C^{2+}, Ni^{+}) with a modified inverse power potential. Results are reported for bombarding energies E_0 between 25 eV and 100 MeV for nickel and stabilized 4988 steel. With the simplified assumption that only simple Frenkel defects (vacancy-interstitial pairs) are produced, it follows that the reactors EBR II and DFR have almost twice the damage rate as obtained in SNR. In the case of ion bombardment, the damage rate near the end of the range is several orders of magnitude larger than in the neutron case, so consequently much shorter irradiation times are required. Problems of spikes vs Frenkel defect production are discussed in terms of the mean free displacement path and of the mean transferred energy. (auth)

24657 (LYCEN-7163) CHANNELING EFFECTS ON RUTHERFORD SCATTERING YIELDS IN THIN SINGLE CRYSTALS. Poizat, J-C.; Remillieux, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Sep 1971. 13p. (CONF-710949-1). Dep. NTIS (U. S. Sales Only).

From International conference on atomic collisions in solids; Gausdal, Norway (20 Sep 1971).

Results are presented on the Rutherford scattering yield of 1-MeV protons by a 500-Å-thick gold crystal. Experimental results obtained for planar channeling are in good agreement with the theoretical values for the depth χ_m and the half-width $\Psi_{\frac{1}{2}}$ obtained from calculations taking into consideration the thermal motion of the lattice atoms, and the effects of multiple scattering on the scattering yield. The experimental χ values obtained along various axes suggest that the effect of channeling on the axial scattering yield should be considered as a combination of planar effects. Calculations are being developed to study the comparative effect of the thermal motion of the lattice atoms and the nuclear lifetime on the blocking dip of the emerging charged particles issued from a nuclear reaction. (France)

24658 DYNAMICS OF F_2^+ CENTERS IN LiF: ONE PHONON SIDEBAND AND RAMAN SCATTERING. Farge, Y.; Fontana, M. P. (CNRS, Orsay, France). Solid State Commun.; 10: No. 4, 333-6(15 Feb 1972).

The vibrational structure of the F_2^+ emission in electron-irradiated LiF was investigated, together with the resonant Raman scattering from the first excited electronic state. The one-phonon sideband of the emission and the resonant Raman spectrum were found to be very similar, as expected for transitions involving nondegenerate electronic states. (auth)

24659 DIMPLING: A NEW MANIFESTATION OF ION-PRODUCED LATTICE DAMAGE. Meek, R. L.; Gibson, W. M.; Sellschop, J. P. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Radiat. Eff.; 11: No. 3-4, 139-47(Dec 1971).

Bombardment of thin (1 to 10 μ) single-crystal targets of silicon and germanium with energetic ion beams was found to result in macroscopic distortion of the thin film in the bombarded region. This effect, which has been termed a "dimple," is readily observed with the naked eye even at relatively low particle fluence. A useful first-order model was developed which interprets the dimpling as an expansion of the bombarded region. For very thin samples this expansion can be accommodated by bowing of the crystal out of the original crystal plane, and for this simple model the fractional expansion is proportional to $(\delta/d)^2$ where δ is the maximum displacement from the original crystal plane and d is the diameter of the bombarded area. Such a measurement allows expansion to be determined with a sensitivity comparable to or better than the most sensitive existing methods. (UK)

24660 PROTON CHANNELING STUDIES IN THIN CRYSTALS WITH A SUPERCOLLIMATED BEAM. Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.); Gibson, W. M.; Wegner, H. E. Radiat. Eff.; 11: No. 3-4, 241-9(Dec 1971).

A supercollimated beam of 4-MeV H^- ions with an angular spread of 1.5×10^{-3} degrees, a diameter of 25 μ, and a current of 10 picoamps was used to study the axial and planar channeling characteristics of single-crystal silicon samples ranging in thickness from 0.5 to 1.0 μ. Since the angular spread of the beam was much smaller than most of the gross angular phenomena associated with channeling, it was possible to study the detailed characteristics of both planar and axial channeling with greater precision than before. Preliminary results indicate that this technique will allow a direct study of interatomic or continuum potential distributions and will also be useful for studying nuclear multiple scattering as a function of the transverse energy of channeled particles relative to atomic rows and planar directions. (auth)

24661 THERMOLUMINESCENCE AND ANNEALING OF F CENTRES IN KCl γ IRRADIATED AT ROOM TEMPERATURE. Ausin, V.; Alvarez Rivas, J. L. (JEN, Madrid). J. Phys., C (London); 5: No. 1, 82-96(17 Jan 1972).

The thermoluminescence spectrum and phosphorescence decays of Harshaw KCl samples γ irradiated at room temperature were studied up to 400°C. For the six peaks found the order of the kinetics of recombination, the pre-exponential factor, and the activation energy were obtained. It was observed that the area under the thermoluminescence curve is always proportional to the F-center concentration in the sample before heating. It was also found that there is an annealing step of F centers corresponding to each thermoluminescence peak, when the temperature of the sample is raised at a constant rate. It is concluded that the F centers play the role of recombination centers in the annealing process, the interstitials being the mobile entities moving towards the recombination center. At some stage in the process, light is emitted. The spectral analysis of this light shows that the emission band has its maximum at 440 μm for all the thermoluminescence peaks. (auth)

24662 RADIATION DAMAGE FROM INTERNAL ALPHA DECAY IN THORIUM. Schmidt, Dorn Lewis. Davis, Calif.; Univ. of California (1971). 96p. University Microfilms Order No. 72-3603.

Thesis.

A promising new technique was investigated for producing radiation damage in metals by homogeneously doping the metal (in this case thorium) with some short-lived atomic species whose decay produces sufficient radiation damage to permit study by conventional techniques. The relative advantages and disadvantages are discussed. Radiation damage was accumulated at 4.2°K and a rough isochronal anneal covering the temperature range 4.2 to 1150°K was performed. Additional isochronal and isothermal recovery studies were performed in the temperature range 4.2 to 80°K. The upper boundaries of the various stages are: Stage I (48°K), Stage II (230°K), Stage III (400°K), Stage IV (1100°K). Total Stage I recovery was only 30%. Stage I was found to have five substages with assignments of substage sources being the same as in copper. Long-range interstitial migration in Stage I_E was clearly demonstrated, but distinction between various interstitial models was not possible. Activation energies were determined for the following stages: I_B (0.021 ± .002 eV), I_D (0.0875 ± .002 eV), I_E (0.0869 ± .002 eV), and, subject to assumptions II_A (0.100 ± .01 eV) and II_B (0.182 ± .01 eV). (Diss. Abstr. Int., B)

24663 STAGE III RECOVERY IN ELECTRON-IRRADIATED ALUMINUM. Anderson, Thomas Gordon, Jr. Clemson, S. C.; Clemson Univ. (1971). 103p. University Microfilms Order No. 72-5038.

Thesis.

Thin foils of high-purity aluminum were irradiated with electrons of 0.4 and 0.5 MeV. The 0.4-MeV experiment was carried out as a dose-dependent investigation, with the high dose being ~ ten times the low dose. All samples were isochronally annealed through the Stage III region (150 to 325°K), and the data for the two high-dose samples irradiated at 0.4 MeV and all samples irradiated at 0.5 MeV were analyzed to determine which one of several theoretical rate equations best describes the observed recovery. The Stage III region actually consists of three substages, the first two of which comprise approximately 20% of the total of the Stage III region and whose height and location on the temperature scale are quite sample-dependent. The third substage can be described as being due to the migration of a single point defect having an activation energy of 0.56 eV and obeying second-order kinetics. In the 0.5-MeV experiment, 2% of the total damage

remained at the end of Stage III, in contrast to the 0.4-MeV experiment, where all of the damage was recovered at the end of Stage III. The 2% of the total damage remaining in the 0.5-MeV experiment can be explained in terms of the formation of a complex type of damage by this higher irradiation energy. This explanation is also consistent with the shape of the high-temperature side of the main recovery peak for the 0.5-MeV irradiations, which indicates that recovery is proceeding at a lower rate in this region. The percent of damage retained until Stage III is inversely related to the dose, so that Stage III contains a higher percent of the total damage for the low-dose samples. The fact that the observed activation energy of migration for the Stage III defect (0.56 eV) agrees closely with the migration energy of the single vacancy obtained by independent methods indicates that the Stage III defect is the single vacancy. (Diss. Abstr. Int., B)

24664 RADIATION-INDUCED EXTRINSIC PHOTOCONDUCTIVITY IN Li-DOPED Si. Fenimore, E.; Mortka, T.; Corelli, J. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys.; 43: No. 3, 1062-73(Mar 1972).

A brief description is given of instrumentation and methods used in the study of radiation damage in lithium-diffused Si. Infrared photoconductivity (1 to 10 μ) and infrared spectroscopy (1 to 50 μ) were used as the probes. The defects were induced in the material by 1.5-MeV electrons with the sample temperature at 300°K during irradiation; one irradiation experiment was run at ~110°K. No infrared-active defect bands were induced by electrons of $E \lesssim 5$ MeV up to radiation fluences of 3.3×10^{17} e/cm^2. All samples studied with lithium concentrations in the range 9×10^{15} to 2×10^{17} cm^{-3} exhibit sharp increases in resistance after heat treatment in the range 200 to 700°K. Dominant radiation-induced photoconductivity arises from levels at $E_c - 0.2$, $E_c - 0.39$, $E_c - 0.54$, $E_c - 0.6$, $E_c - 0.7$, and $E_c - 0.8$ eV in oxygen-rich Si and at $E_c - 0.2$, $E_c - 0.54$, $E_c - 0.8$, $E_c - 0.92$, and $E_c - 1.0$ eV in oxygen-lean Si. The levels are found to disappear and in some cases shift with annealing in the 100 to 450°C temperature range. In all cases the spectrum is dominated by three or four energy levels after irradiation and after various anneals. Energy levels obtained by other workers using carrier concentration, minority carrier lifetime, and photoluminescence as the probes are compared to the measurements reported here. (auth)

24665 CHANGE IN THE INTRINSIC OPTICAL ABSORPTION OF GERMANIUM AND SILICON UPON IRRADIATION. Primak, William; Buck, Warren (Argonne National Lab., Ill.). J. Appl. Phys.; 43: No. 3, 799-80(Mar 1972).

Optical constants calculated from ellipsometry data at 0.546 and 0.644 μ for germanium and for Ne^+(140-keV)-bombarded germanium indicated a 0.4-eV displacement of the optical-absorption edge to longer wavelength. Optical examination of silicon with a photomultiplier tube gave evidence of a radiation-induced increase of optical absorption in the tail of the absorption edge. (auth)

24666 FORMATION OF AMORPHOUS SILICON BY ION BOMBARDMENT AS A FUNCTION OF ION, TEMPERATURE, AND DOSE. Morehead, F. F.; Crowder, R. L.; Title, R. S. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 3, 1112-18(Mar 1972).

The dose (fluence) of 200-keV boron, phosphorous, and antimony ions required to produce a continuous amorphous layer in silicon is determined as a function of target temperature. EPR measurements are used to monitor the process, which is also then related to annealing effectiveness. The continuous amorphous layer recrystallizes at 550°C, after which only the implanted ions within that layer are completely electrically active. Carrier concentration profiles indicate the position of the amorphous layer and allow an approximate determination of the distribution with depth of damage. At the low dose rates used, reasonable agreement with a simple model for the formation of amorphous silicon as a function of ion, temperature, and dose is obtained. (auth)

24667 SPUTTERED ATOM EJECTION FROM Ge AND THE ANNEALING OF ION BOMBARDMENT INDUCED DISORDER. Zwangobani, E. D.; MacDonald, R. J. (Australian National Univ., Canberra). Radiat. Eff.; 11: No. 3-4, 215-20(Dec 1971).

It was previously established that it is necessary to keep single targets of Ge and Si above a certain critical temperature T_a before an ejection pattern indicative of surface order can be obtained. A study is reported on the dependence of the disorder-to-order transition temperature, T_a, on the incident ion mass, the dose rate, and the crystallography of the target. The disorder-to-order transition temperature, T_a, was measured for 5, 10, and 15-keV Ar^+, Kr^+, and Ne^+ bombardment of (111), (110), and (100) Ge, using the sputtered atom ejection pattern to indicate the restitution of order. The dose-rate dependence of the transition temperature, T_a, was used to calculate activation energies for the transition occurring. (auth)

24668 SPATIAL DISTRIBUTION OF IONS INCIDENT ON A SOLID TARGET AS A FUNCTION OF INSTANTANEOUS ENERGY. Brice, D. K. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 11: No. 3-4, 227-40(Dec 1971).

Integro-differential equations are derived that govern the spatial distribution of ions of energy E′ moving in a solid target after the ions were incident on the target surface with energy E. These equations are specialized to integral equations which govern the first and second spatial moments of the distribution. Solutions to the moments equations are obtained to second order for an expansion of the integrands in powers of T, the energy transfer in a single collision between an ion and an atom (or electron) of the target. Similar equations are also derived for the average range along path of the ions at energy E′. (auth)

24669 THERMOLUMINESCENCE OF X-IRRADIATED NaCl:Tl. Joshi, R. V.; Joshi, T. R. (MS Univ. of Baroda, India). J. Phys., D (London); 5: No. 2, 446-7(Feb 1972).

Thallium-doped NaCl crystals, x-irradiated at room temperature, were heated to 525°K for glow-curve measurements. The recorded glow curves showed two definite peaks: at 340 and 500°K. Study of the growth of these peaks with x-irradiation time indicated that the 500°K peak may be related to some species of interstitial clusters. (auth)

24670 BAND GAP OF TRIGLYCINE SELENATE, TRIGLYCINE FLUOROBERYLLATE, TRIGLYCINE SULFATE, AND ITS VARIATION UNDER γ-IRRADIATION. Sirota, N. N.; Korina, R. V. (Inst. of Physics of Solids and Semiconductors, Minsk). Krist. Tech.; 6: No. 3, 387-93(1971).

The band gaps, E_g = 5.06, 5.013, and 4.885 eV, respectively, for optically active crystalline triglycine sulfate (TGS), triglycine selenate (TGSe), and triglycine fluoroberyllate (TGFB) were determined from measurements of the spectral dependences of the optical density near the self-absorption edges (~245–53 mμ) at room temperature. After irradiation (~2 to 7) $\times 10^7$ rad) by ^{60}Co γ rays at 40°, the E_g values decreased by 1.8, 1.65, and 1.5 eV, for TGS, TGSe, and TGFB, respectively, owing to radiolysis processes; the self-absorption edges shifted to longer wavelengths (~368–72 mμ). (Selenium-Tellurium Abstr.)

24671 INTERSTITIALS IN PLATINUM. Jackson, J. J. (Argonne National Lab., Ill.). Radiat. Eff.; 11: No. 3-4, 201-14(Dec 1971).

The defect production rate in platinum irradiated with energetic charged particles was measured as a function of irradiation temperature from below recovery stage I to above the so-called stage III. On the basis of these measurements, supplemented by recovery studies and by other types of irradiations, a consistent model of defect production and recovery in platinum on the basis that two distinct interstitial species are present is put forward. (auth)

24672 DOMAIN WALL MOBILITY ENHANCEMENT THROUGH X-RAY IRRADIATION COMPARED WITH THERMAL ANNEALING. Shumate, P. W. Jr.; Eisenberger, P. M. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys.; 43: No. 3, 1299-1301(Mar 1972).

Flux-grown platelets of $Sm_{0.55}Tb_{0.45}FeO_3$, cut perpendicular to the orthorhombic c axis, were irradiated with Mo x rays. Identical platelets were also thermally annealed in O_2. Measurements of the room-temperature domain wall mobility as a function of exposure time or annealing temperature show remarkable similarities as the mobility is first increased 27% and then falls below its initial (as-grown) value. (auth)

24673 RANGE DISTRIBUTION THEORY BASED ON ENERGY DISTRIBUTION OF IMPLANTED IONS. Furukawa, Seijiro; Ishiwara, Hiroshi (Tokyo Inst. of Tech.). J. Appl. Phys.; 43: No. 3, 1268-73(Mar 1972).

A new analysis is presented of the range distribution of implanted ions in amorphous substrates. In this analysis, energy distributions of an ion are calculated at steps of collisions in the substrate to determine the range distribution, instead of solving integral equations for the moments of the range which is essential in the theory of Lindhard, Scharff, and Schiott. The validity of this analysis is shown for 50-keV Sb ions in both single- and multiple-element substrates by assuming a screening function proportional to 1/r and by comparing with the theory of Lindhard et al. The range distribution for the case of multiple-layer substrates, which cannot be calculated by usual theories, is also considered. The special features obtained for this case are (i) there can be discontinuities in ion concentration at the boundaries of the layers and (ii) for even the same dose, the maximum ion concentration can become higher by depositing an appropriate surface layer on a substrate. (auth)

24674 WAVE THEORY OF LATTICE-DIRECTED TRAJECTORIES. III. THE CLASSICAL LIMIT. Nip, Hans C. H.; Kelly, J. C. (Univ. of New South Wales, Sydney). Phys. Rev., B; 5: No. 7, 2425-30(1 Apr 1972).

The applicability of classical mechanics to lattice-directed trajectories is considered, and a projectile-energy-independent condition is obtained. A critical angle for channeling is obtained without the introduction of a continuum-wall approximation to the interaction potential. An interaction equation is derived in terms of relativistic particle mechanics from the conservation of energy and angular momentum. It is also shown by separation of variables in a former equation, this classical theory is contained in the previously developed wave treatment of lattice-directed trajectories. (auth)

24675 ELECTRON AND PROTON RADIOLUMINESCENCE OF OPTICAL GLASSES. Akishin, A. I.; Bessonova, T. S.; Vasil'ev, S. S. Zh. Prikl. Spektrosk.; 15: No. 3, 471-5(Sep 1971). (In Russian).

Luminescence characteristics of multicomponent optical silicate glasses when excited by electrons and protons were studied. The emitted light beams depend linearly on the intensity of ionizing radiation. The energy yield from proton excitation is less than that from electron excitation. During prolonged bombardment of glasses by electrons and protons, an increase of luminescent output occurred in the absence of lead oxide in the glass, and thermoluminescence occurred at elevated temperatures. Lead oxide glass exhibited a constant luminescent output. (tr-auth)

24676 IONIZATION, THERMAL, AND FLUX DEPENDENCES OF IMPLANTATION DISORDER IN SILICON. Picraux, S. T.; Vook, F. L. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 11: No. 3-4, 179-92(Dec 1971).

Proton-channeling-effect measurements were used to study the implantation lattice disorder in silicon as a function of ion flux (dose rate), fluence, implant temperature, ion mass, and the presence of ionizing radiation. For both O^+ and Sb^+ implantation at 87°K, lattice-disorder production was the same for equal total energy into atomic processes/cm^3 at a fixed rate of energy into atomic processes/cm^3-sec. The disorder production for both light (O^+) and heavy (Sb^+) ions exhibited a flux dependence at low temperatures and at room temperature. At low temperatures, an increase in disorder was observed with increasing flux at constant fluences; however, for low-fluence Sb implantation at 300°K, lower disorder was observed with increasing flux. The lattice disorder increased for all ions with decreasing implant temperature from 300°K down to temperatures as low as 38°K, but the variation with temperature was greater for lighter ions. Stimulation of lattice-disorder annealing (typically ≈10 percent) by ion beams was observed between 87 and 360°K. The results of disorder production and lattice reordering are interpreted in terms of the energy deposited into atomic and electronic processes, and previously observed lattice defect properties in Si. Ionization due to the energy deposited into electronic processes by the ions is believed to stimulate the annealing of defects from a disorder cluster in a manner similar to the charge state and injection-stimulated vacancy annealing previously observed for neutron and electron damage in Si. It is suggested that ionization stimulation of the lattice-disorder annealing during implantation is responsible for the large differences observed in Si between the implant temperature and anneal temperature curves. (auth)

24677 EFFECT OF IMPURITIES ON THERMAL DECOMPOSITION OF ACTIVATED COLOR CENTERS IN NaCl:Ag PHOSPHORS WHEN IRRADIATED WITH ACCELERATED ELECTRONS. Khalilov, A. Kh.; Aliev, F. G. (Inst. of Physics, Baku). Izv. Akad. Nauk. Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 6, 71-5(1970). (In Russian).

The mechanism of thermal decomposition and transformation of some active color centers was studied by means of the spectra of excited phosphors NaCl + Ag after periods of 6 hr and 6 months, following irradiation with a beam of electrons (30 min at 80 and 150°C). The addition of Ca^{2+} to the phosphor lattice (0.01) sharply increased the thermal stability of C and D color centers. The effect of Cd^{2+} on the formation of C and D color centers was insignificant. (K.S.W.)

24678 SPUTTERING YIELD OF SILICON BY ELLIPSOMETRY. Ibrahim, M. M.; Bashara, N. M. (Univ. of Nebraska, Lincoln). Opt. Commun.; 4: No. 5, 339-40(Jan 1972).

Using ellipsometry, the ratio of sputtering yield to sticking probability for silicon is determined from experimentally measured quantities only. For 350-eV argon ions, the sputtering yield and the sticking probability are 0.12 and 0.27, respectively. (auth)

24679 EXPERIMENTAL STUDY OF Co IRRADIATION EFFECT ON RADIATION DAMAGE OF A-KIND INSULATOR. Chee, Chol Kon; Kim, Byung Soo. J. Korean Inst. Elec. Eng.; 20: No. 3, 27-31(1971).

Results of a study of the radiation effects on the electrical properties of an A-type insulator which is one of the organic insulators are reported. The varnished cloth is so typical of the A-type insulators as to be selected for a sample. Ac and impulse voltage is applied to the variable γ-ray irradiated dose samples with the constant time duration and the dielectric breakdown voltage are measured from the sample. The experimental data of the dielectric breakdown voltage are considerably decreased. (Korean Sci. Abstr.)

Physical Properties

Refer also to abstracts 22615, 22915, 24193, and 24209.

24680 (BNL-16517) POSITRON ANNIHILATION AND ITS APPLICATION TO DEFECT STUDIES IN METALS. Goland, A. N. (Brookhaven National Lab., Upton, N. Y.). [1971]. 54p. Dep. NTIS.

A review is presented of the application of positron annihilation to studies of imperfect solids, particularly metals. After a brief review of positron physics, a description is given of the behavior of positrons in perfect metals. Experimental methods that are used to extract information about the electronic structure of solids from the annihilation photons are next considered, and experimental results on defects in metals are examined. A vacancy-trapping model currently in use to explain the observations is discussed. 48 references. (D.L.C.)

24681 (HMI-B-115) PERTURBED ANGULAR DISTRIBUTION FOLLOWING NUCLEAR REACTIONS. Recknagel, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Jan 1972. 53p. Dep. NTIS (U. S. Sales Only).

A review is given of perturbed angular distribution experiments following nuclear reactions (PADENR) and their application to solid-state problems, especially hyperfine interactions. Problems in the nuclear reaction and methods used in PADENR (spin rotation, stroboscopy, γ-NMR, and β-NMR) are described. Nuclear magnetic moments measured by PADENR are tabulated. Some typical solid-state experiments are discussed: liquid targets, transition between liquid and solid targets, and solid targets. (70 references) (D.L.C.)

24682 (IS-2722) DEPENDENCE OF FREE-LATTICE-MODEL FERROMAGNETIC RESONANCE IN TERBIUM AT 24 GHz ON ROTATION OF THE MAGNETIC FIELD IN THE HEXAGONAL PLANE. Hart, L. W.; Stanford, J. L. (Ames Lab., Iowa). [1971]. 5p. (CONF-711108-16). Dep. NTIS.

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

Resonance field position and amplitude for two possible ferromagnetic resonances varied greatly with alignment of the applied magnetic field (H_{dc}) in the range 2 to 10° from the a-axis in the hexagonal plane of the sample (T = 77 to 140°K); these resonances are not easily explained by present theories. The higher field peak is not as well defined and is an order of magnitude broader in line width than the lower field peak. When H_{dc} was aligned 1 to 2° from the a-axis in the hexagonal plane, the resonances followed closely the free lattice model predictions of Vigren and Liu for H_{dc} exactly along the a-axis. The resonances for T = 77 to 140°K were only observable when H_{dc} was not precisely aligned along an a-axis in the hexagonal plane. (auth)

24683 METAL-INSULATOR TRANSITION IN VO_2. Hearn, C. J. (Harvard Univ., Cambridge, Mass.). Phys. Lett.; 38A: No. 6, 447-8(13 Mar 1972).

A model of the phase transition in VO_2 is presented which is based on phonon softening effects and gives quantitative agreement with experiment. (auth)

24684 MAGNETIC SUSCEPTIBILITY OF CUBIC CARBIDES OF Nb AND Ta AT LOW TEMPERATURES. Borukhovich, A. S.; Dubrovskaya, L. B.; Matveenko, I. I.; Gel'd, P. V. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 71-3(1970). (In Russian).

The magnetic susceptibility of cubic carbides of Nb and Ta were measured in their homogeneous regions at low temperatures. A Curie-Weiss behavior was observed for $NbC_{0.88}$ below 30°K. Discussion of the results centers around the electronic structure of these compounds. (tr-auth)

24685 LATTICE DYNAMICS AND SOE CONSTANTS OF TERBIUM USING KEATING'S APPROACH. Menon, C. S.; Rao, R. Ramji (Indian Inst. of Tech., Madras). Solid State Commun.; 10: No. 2, 179-84(15 Jan 1972).

The lattice dynamics and the SOE constants of Tb were worked out, based on Keating's approach using twelve second-order pa-

rameters. The agreement between theory and experiment is extremely satisfactory. The results are compared with those of Houmann and Nicklow (Phys. Rev., B1: 3943(1970)) who used 22-force-constant parameters in their "mixed model." (auth)

24686 SPIN–LATTICE RELAXATION OF (J = 0) MOLECULES IN SOLID AND LIQUID D_2. Harris, A. Brooks (Univ. of Pennsylvania, Philadelphia). Solid State Commun.; 10: No. 4, 329-32(15 Feb 1972).

The spin–lattice relaxation rate for (J = 0) molecules in solid D_2 due to fluctuating distortions induced by neighboring (J = 1) molecules is calculated. It is found that $T_1(J = 1)/T_1(J = 0) \propto x(\Gamma/B)^2$, where Γ is the quadrupolar coupling constant, B the rotational constant, and x the concentration of (J = 1) molecules. This calculation is qualitatively confirmed in liquid D_2 and a proposal for its verification in the solid phase is presented. (auth)

24687 MAGNETOELASTIC DEPENDENCE OF THE ATTENUATION OF SOUND AND THE ELASTIC CONSTANT c_{33} IN CRITICAL-POINT GADOLINIUM. Long, Marshall Jr. Los Angeles; Univ. of California (1971). 108p. University Microfilms Order No. 72-2852.

Thesis.

The changes in the attenuation of sound and in the elastic constant c_{33} of gadolinium were measured as functions of applied magnetic fields of up to 13 kOe in the temperature range 270 to 320°K. The minimum in the elastic constant at the Curie point moved upwards in temperature and tended to diminish and broaden with increasing field. Studies of the change in attenuation due to magnetic field in the same region revealed sharp lambda-shaped increases up to a field of 1.8 kOe. At higher fields this peak split into two diminishing maxima, one moving upwards and the other downwards with increasing field. The behavior of the elastic constant is laid to the effect of the field on the spin correlation function, while that of the attenuation is as yet unknown. (Diss. Abstr. Int., B)

24688 PREPARATION, ELECTRICAL, AND SUPERCONDUCTING PROPERTIES OF MASSIVE Th_4H_{15}. Satterthwaite, C. B. (Univ. of Illinois, Urbana); Peterson, D. T. J. Less-Common Metals; 26: No. 3, 361-8(Mar 1972).

Massive specimens of Th_4H_{15} were prepared by a high-pressure, high-temperature synthesis. These specimens showed superconducting transitions at 7.5 to 8.5 K by magnetic and resistance measurements. The transition was narrower than in powdered Th_4H_{15} samples but still not isothermal. The electric resistivity Th_4H_{15} was measured from 4.2 K to 300°K. This compound is a metallic conductor and has a resistivity minimum near the stoichiometric composition. (auth)

24689 SINGLE CRYSTAL NEUTRON DIFFRACTION STUDY OF BINARY RARE EARTH ALLOYS. Millhouse, A. H.; Koehler, W. C. (Oak Ridge National Lab., Tenn.). Int. J. Magn.; 2: No. 1, 389-403(Nov 1971).

Single-crystal samples of Ho–Dy, Er–Gd, Er–Tb, Er–Dy, and Ho–Er alloys were prepared using the strain–anneal technique, and neutron-diffraction studies of these samples were made from room temperature to 4.2°K to determine their magnetic structure properties. In most cases a detailed study of the intensities of several important reflections was made as a function of temperature. The temperature dependence of the ordered atomic moment and its projections along the c-axis and upon the crystal basal plane were calculated using the magnetic structure models proposed for the pure metals. These models are found to be satisfactory for the alloys. In the alloy systems Er–Tb, Er–Dy, and Ho–Er the best agreement with the measured moment values is obtained by assuming that the Tb, Dy, or Ho moments are parallel to the Er moments within hexagonal layers at 4.2°K. The observations made on the alloys appear to be generally explicable by the combination of exchange and anisotropy which has been used for the pure metals. The observation of a sinusoidal c-axis oscillation at a lower temperature than the helical configuration is not, however, predicted by molecular field theory arguments. (auth)

24690 DISLOCATION RELAXATION IN MOLYBDENUM. Mongy, M. (Univ. of Uppsala). Nuovo Cim.; 8B: No. 1, 247-55(11 Mar 1972).

Dislocation relaxation peaks were investigated in the three principal directions [100], [110], and [111] of a single crystal of molybdenum at the frequencies 10, 20, and 50 MHz. The activation energies and the relaxation frequencies calculated from the position of the peak show a high degree of anisotropy from one direction to the other, and the lowest values are obtained when the ultrasonic waves are applied parallel to the [100] direction. The comparison of the peak with Zener's single-relaxation theory shows that the peak in the [100] direction is due to a single relaxation process. In the other two directions, the results favor a spectrum of different relaxation frequencies with a constant activation energy. This result is in qualitative agreement with the data obtained earlier for fcc metals and gives strong support to the idea that dislocation relaxation peaks arise from the same mechanism in both fcc and bcc metals. (auth)

24691 ENERGY LOSS OF CHANNELED PROTONS DETERMINED IN AN INDIRECT WAY. Hellborg, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Scr.; 4: No. 1-2, 75-82 (1971).

By an indirect method, the energy-loss rate of protons channeled along close-packed directions in single crystals was determined. The dechanneling effect observed in Rutherford scattering and nuclear reaction yields was used. The method was applied to different close-packed axes in single crystals of CaF_2 and BaF_2. Experimental values down to about 0.60 for the ratio of energy-loss rate in channel and random directions were found. (auth) (Sweden)

24692 MAGNETOSTRICTIVE EXCITATION OF SOUND IN MAGNETIC MATERIALS. Gorodetsky, G.; Luethi, B.; Moran, T. J.; Mullen, M. E. (Rutgers–The State Univ., New Brunswick, N. J.). J. Appl. Phys.; 43: No. 3, 1234-8(Mar 1972).

Experimental results for magnetostrictive generation of sound waves in various magnetic materials are given. Enhancement effects for this generation are studied near the spin reorientation transition in Er FeO_3, near ferromagnetic resonance in Fe_3O_4, and near the magnetic phase transition in Tb. Second-harmonic sound generation in Fe_3O_4 and Tb is reported. All these results can be explained semiquantitatively using magnetic symmetry arguments. (auth)

24693 ELECTRONIC CONDUCTION IN CALCIA-STABILIZED ZIRCONIA BETWEEN 1000 TO 1400°C. Rao, A. V. Ramana; Tare, V. B. (Banaras Hindu Univ., India). Scr. Met.; 6: No. 2, 141-8(Feb (Feb 1972).

An investigation was conducted to determine the lower P_{O_2} limit above which calcia-stabilized zirconia (CSZ) acts as a pure ionic conductor. The following cells were used: Cr, Cr_2O_3/CSZ/Nb, NbO and Cr, Cr_2O_3/CSZ/Ta, Ta_2O_5. The value of log P_{O_2} varied from −21 at 1000°C to −12 at 1400°C, and the electronic conduction was 6 and 17%, respectively. The free energy of formation of Ta_2O_5 was also calculated from the emf data. Tests were conducted to determine whether the Cr, Cr_2O_3 electrode is a pure ionic conductor. (D.L.C.)

24694 RESPONSE OF THE ELECTRICAL RESISTANCE OF MOLYBDENUM OXIDE SINGLE CRYSTALS TO HYDROGEN IN AIR. Buckman, William G. (Western Kentucky Univ., Bowling Green). J. Appl. Phys.; 43: No. 3, 1280-1(Mar 1972).

The electrical resistance of MoO_3 single crystals activated with platinum was measured in air and in air containing 1% molar hydrogen concentration over the temperature region of 500 to 700°K. The electrical resistance of the single crystal in air at 653°K was about 10^8 Ω and decreased by a factor of 30 when exposed to the hydrogen atmosphere. These results strongly suggest that MoO_3 may be used to monitor hydrogen concentrations where possible hazardous concentrations may occur. (auth)

24695 ELECTRICAL CHARACTERISTICS OF rf-SPUTTERED SINGLE-CRYSTAL NIOBIUM FILMS. Mayadas, A. F.; Laibowitz, R. B.; Cuomo, J. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 3, 1287-9(Mar 1972).

It is shown from measurements of the resistivity ratio (RR = resistivity at room temperature divided by resistivity at 10°K), superconducting transition temperature, and transition-temperature width that high-quality single-crystal niobium films can be fabricated by rf sputtering. The observed dependence of RR on sample thickness indicates that the intrinsic electron mean free path increases with thickness. Superconducting characteristics are essentially thickness independent for films thicker than approximately 1000 Å. (auth)

24696 MAGNETIC AND STRUCTURAL PHASE TRANSITION IN DySb. Bucher, E. (Bell Labs., Murray Hill, N. J.); Birgeneau, R. J.; Maita, J. P.; Felcher, G. P.; Brun, T. O. Phys. Rev. Lett.; 28: No. 12, 746-9(20 Mar 1972).

The magnetic properties of DySb were studied using specific-heat, susceptibility, and neutron-scattering techniques. It is found that there is a single first-order magnetic phase transition with a marked lattice distortion at 9.5°K. This result is in disagreement with recent work claiming successive structural (quadrupole) and magnetic phase transitions at 11.5 and 9.5°K, respectively. (auth)

24697 ABSOLUTE PROBABILITIES OF TRANSITION LINES OF MOLYBDENUM. Kirsanova, N. N. Zh. Prikl. Spektrosk.; 15: No. 3, 536-8(Sep 1971). (In Russian).

The transition probabilities of 20 Mo lines were determined for analytical application by measuring the relative intensities in the spectral region 450 to 510 nm. The excitation source was a dc arc. The results were placed on an absolute scale using Cr lines with known absolute values. (tr-auth)

24698 SPECTROSCOPIC PROPERTIES AND THE GENERATION OF Nd^{3+} IN ZrO_2 AND HfO_2 CRYSTALS. Aleksandrov, V. I.; Voron'ko, Yu. K.; Mikhalevich, V. G.; (and others) (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 6, 1282-3(21 Aug 1971). (In Russian).

Nd-activated materials find use in laser applications, which prompted a study of the spectroscopic properties and the generation of Nd^{3+} in cubic crystals of ZrO_2 and HfO_2. The Nd^{3+} content was allowed to fluctuate between 0.1 and 1%, and CaO or Y_2O_3 was added for structure stabilization. The absorption spectrum for HfO_2–0.7% Nd^{3+} at 300°K is depicted and discussed. (K.S.W.)

24699 FERMI RADII OF LITHIUM BY POSITRON ANNIHILATION. Paciga, J. J.; Williams, D. Llewelyn (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: No. 24, 3227-33(15 Dec 1971).

A collinear-point detector geometry was used to study positron annihilation in single-crystal lithium. The results are interpreted in terms of the higher momentum components of the electron wave functions and the lithium Fermi surface. A consistent interpretation favors a value for the Fourier component V_{110} of the lattice potential of close to 0.10 Ry and a Fermi surface whose radius in the [110] direction is 2.9% greater than in the [100] direction. This latter result is consistent with Compton-scattering data and both results are in close agreement with the recent band-structure calculations of Rudge. (auth) (Canada)

24700 DETERMINATION OF OPTICAL CONSTANTS OF SOLIDS BY ENERGY LOSS OF MEDIUM-FAST ELECTRONS. Raether, Heinz (Univ., Hamburg). pp 335-50 of Advances in Solid State Physics. /Madelung, O. (ed.). Elmsford, N. Y.; Pergamon Publishing Co. (1970). (In German).

Electrons can produce longitudinal excitations of the solid with a dielectric constant $\epsilon = \epsilon_1 + i\,\epsilon_2$. They transfer an energy $\Delta E = \hbar\omega$ and a momentum $\hbar q$ to the crystal electrons. The excitation probability being proportional to $\mathrm{Im}\,[-1/\epsilon(\omega)]$, the evaluation of the electron energy-loss spectrum allows the determination of $\epsilon(\omega)$ of isotropic and anisotropic crystals. Examples are given for metals, insulators, and semiconductors. The q-valve transferred to the crystal electrons can become comparable with the extension of the Brillouin zone so that the q-dependence of $\epsilon(\omega,q)$ comes into play. This effect is demonstrated on graphite. (For announcement of book from which this article was taken see NSA 25: 43483). (23 references) (auth)

24701 SEMICONDUCTOR PROPERTIES OF BORON. Werheit, H. (Univ., Cologne). pp 189-226 of Advances in Solid State Physics. /Madelung, O. (ed.). Elmsford, N. Y.; Pergamon Publishing Co. (1970). (In German).

This review is essentially restricted to β-rhombohedral boron. The semiconductor properties of β-rhombohedral boron are mainly determined by trapping levels for electrons and holes of great density of states. Indirect transitions occur between valence and conduction bands; optical transitions from the valence band into the electron trapping level are forbidden, but at high temperatures this level becomes thermally occupied. Optical, photoelectric, and electrical measurements supply consistent values of the energetic position of the band edges and the trapping levels. The ionization energy of trapped electrons is much greater than that of trapped holes, so the electrons do not appreciably contribute to the charge transport up to high temperatures. At low temperatures, hopping within the hole trapping level is the prevailing conduction mechanism; at higher temperatures conductivity by holes thermally excited into the valence band becomes more important. Also at high temperatures, the lifetime of holes before retrapping is rather short because of the high concentration of traps. Therefore, the low mobility of the carriers should not be assigned to an extremely great effective mass, but can be described by an activation energy according to the distance between valence band and trapping level. The concentration of imperfections in very pure boron surpasses the number of impurities by about two orders of magnitude. Up to now it cannot be decided whether the trapping levels belong to the electronic band structure of boron or are generated by lattice imperfections. At any rate, the influence of lattice defects on the conductivity mechanism was proved. (For announcement of book from which this article was taken, see NSA 25: 43483.) (64 references). (auth)

24702 CONDUCTIVITY BAND OF NONSTOICHIOMETRIC VANADIUM MONOCARBIDE. Borukhovich, A. S.; Volkova, N. M. (Inst. of Chemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1354-7(Sep 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 9, 1529-32(Sep 1971).

The concentration–temperature dependences of the magnetic susceptibility, electrical resistance, Hall effect, and thermo-emf of vanadium monocarbides of various compositions were studied. The idea of a "quasi-rigid" band, which follows from theoretical calculations of the electron-energy structure of equiatomic TiC, cannot be applied to the case of VC_x. For vanadium monocarbide, a marked effect is exerted by the presence of two types of carriers, electrons and holes, in the conduction band; this governs the behavior of its kinetic properties and is attributed to the presence of hole sections in the Fermi surface. (auth)

24703 RADIO FREQUENCY SIZE EFFECT AND THE FERMI SURFACE OF TUNGSTEN. Boiko, V. V.; Gasparov, V. A. (Physical-Technical Inst., Sukhumi, USSR. Inst. of Solid State Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2362-72(Dec 1971). (In Russian).

Anisotropy of the extreme dimensions of the tungsten Fermi surface in two crystallographic planes (100) and (110) was studied by means of the radiofrequency size effect. The shape and sizes of all sections of both the electron and hole parts of the surface are determined by analysis of the results obtained. An empirical model of the Fermi surface for tungsten is set up and compared with the Fermi surface for molybdenum and with the theoretical calculations. The differences are discussed from the standpoint of a possible effect of relativism on the band structure of the metals. Estimates are made of the electron and hole velocities on various sections of the Fermi surface of tungsten. (auth)

24704 ELECTRON EFFECTIVE MASS IN ScN. Harbeke, G.; Meier, E.; Dismukes, J. P. (RCA Labs., Zurich). Opt. Commun.; 4: No. 5, 335-8(Jan 1972).

The electron effective mass of ScN with carrier concentrations in the range of 10^{20} to 10^{21} cm^{-3} was determined from measurements of infrared reflectivity. An extrapolation of the measured values to low carrier concentrations yields a value between 0.1 and 0.2 m_0. For the refractive index a value $n \geq 3.28$ was obtained. The results are discussed in conjunction with the calculated band structure. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 22889, 22923, and 23337.

24705 (IS-2727) NMR STUDY OF THE ANTIFERROMAGNETIC TRANSITION IN $V_xCr_{1-x}B_2$. Schoenberger, R. J.; Barnes, R. G. (Ames Lab., Iowa). [1971]. 5p. (CONF-711108-15). Dep. NTIS.

From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

The Cr-rich side of the $V_xCr_{1-x}B_2$ system is characterized by a ^{51}V NMR spectrum having a Knight shift, K = −0.12%, whereas K = −0.33% in VB_2. A second resonance, with K = −0.24%, was identified as that of ^{51}V in Cr_3B_4 and indicates that the mixed diborides are not readily prepared as single-phase materials. Both the ^{11}B and ^{51}V resonances are extinguished by the onset of the Cr-like transition that occurs for $x \leq 0.25$. For x = 0, T_N = 86°K, and the extinction of the ^{11}B resonance intensity is indistinguishable from the behavior of ^{53}Cr in chromium. For x > 0, the transition is typically much broader. Although susceptibility data indicate Curie–Weiss behavior above 100°K, with a moment on the order of 2 μ_B, the Cr-like nature of the NMR transition strongly suggests that the transition involves the onset of a spin-density wave. In this respect, this system exhibits some features very similar to those of γ-Mn. (auth)

24706 STARK SHIFT OF NUCLEAR SPIN LEVELS OF ^9Be IN BERYLLIUM OXIDE. Thorland, Rodney H. Jr. Atlanta; Emory Univ. (1971). 40p. University Microfilms Order No. 72-3043.

Thesis.

Measurements of the angular variation of the quadrupole splitting in the NMR spectrum of ^9Be in single-crystal BeO are reported and give $e^2qQ/h = 39.4 \pm 0.2$ kHz. The dependence of the field gradient parameter q on an applied external electric field is investigated and interpreted using the phenomenological relation of Armstrong et al. (Phys. Rev. Lett. 7, 11 (1961)), $e(\Delta q)_{ij} = \Sigma R_{ijk}E_k +$

$\Sigma\Sigma T_{ij1m} e_{1m}$. The strain-induced part of Δq is measured separately and found to be negligible compared with the part due directly to the electric field. An experimental value for R_{zz} of $\pm(1.3 \pm 0.5) \times 10^9$ cm^{-1} is reported. Calculations of R_{zz} on the basis of ionic and covalent models of the BeO structure give -4.1×10^8 cm^{-1} and -8.2×10^8 cm^{-1} respectively for the ionic and covalent contributions and a total calculated R_{zz} of -1.2×10^9 cm^{-1}. It is thus unlikely that the ionic model can account for the observed Stark shift. A determination of the crystal c-axis was made via the pyroelectric effect and this, together with the Stark shift data, indicate that the sign of the field gradient is positive. (Diss. Abstr. Int., B)

24707 NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY. I. THEORY AND EXPERIMENTAL TECHNIQUES. Hoffmann, Stanislaw K. Postepy Fiz.; 23: No. 1, 7-24(1972). (In Polish).

A brief survey of nuclear quadrupole methods is given. The principles of theory and experimental techniques are described. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 23450, 23723, 23986, 23995, and 24491.

24708 (BMBW-FBK-71-21) AXIOMATICS OF COMPOSED QUANTUM MECHANICAL SYSTEMS. Hartkaemper, A.; Neumann, H. (Marburg Univ. (West Germany). Institut fuer Theoretische Physik (I)). Dec 1971. 29p. (In German). Dep. NTIS (U. S. Sales Only).

An irreducible quantum mechanical system, which is composed of irreducible systems (1) and (2), is described by the tensor product $H = {}^{(1)}H \times {}^{(2)}H$. ${}^{(1)}H$ resp. ${}^{(2)}H$ being the hilbert space of the system (1) resp. (2). The ray representation of the given space-time group G is the product of the representations of G in ${}^{(1)}H$ and ${}^{(2)}H$. An attempt is made to give a motivation of this prescription in terms of Ludwig's axiomatic foundation of quantum mechanics. (auth)

24709 (NP-19213) EXACT STATISTICAL-MECHANICAL TREATMENT OF A ONE-DIMENSIONAL QUANTAL MANY-BODY SYSTEM. Note No. 332. Calogero, F. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 6 Sep 1971. 10p. Dep. NTIS (U. S. Sales Only).

The system consists of N_1 particles of type 1 and N_2 particles of type 2, with $N = N_1 + N_2$ fixed and large. The particles of type s interact among themselves via the 2-body "centrifugal" potential $g_s(x_i - x_j)^{-2}$; all particles interact with the external "oscillator" potential $\frac{1}{2} m\omega^2 x_i^2$, with ω small, $\omega \sim 1/N$. Depending on the nature of the particles of each type (identical or distinguishable), at zero temperature a phase transition does or does not occur. (auth)

24710 PERTURBATIONS OF THE SCHROEDINGER EQUATION BY POTENTIALS WITH SMALL SUPPORT, SEMIGROUP PRODUCT FORMULAS, AND APPLICATIONS TO QUANTUM MECHANICS. Friedman, Charles Nathaniel. Princeton, N. J.; Princeton Univ. (1971). 77p. University Microfilms Order No. 72-2704.

Thesis.

Some problems in the theory of perturbations of unitary propagators and semigroups of operators are treated, with applications to mathematical problems of theoretical physics. (TSS) (Diss. Abstr. Int., B)

24711 DYSON EQUATION FOR THE LINEAR RESPONSE FUNCTION. Schuck, P. (Technische Univ., Munich). Phys. Lett.; 38A: No. 4, 251-2(14 Feb 1972).

An integral equation for the linear response is derived which is completely analogous to Dyson's equation for the one-particle Green function. The corresponding particle-hole self-energy for which an explicit expression is given depends only on the frequency and the wave-number of the applied field. In other words this means that no longer an integral equation has to be solved either in energy or in momentum space. (auth)

24712 PERTURBATION OF QUASI-LEVELS FOR THE SCHROEDINGER OPERATOR WITH COMPLEX POTENTIAL. Gataullin, T. M.; Karasev, M. V. (Moscow State Univ.). Teor. Mat. Fiz.; 9: No. 2, 252-63(Nov 1971). (In Russian).

The concepts of energy levels and quasi-levels are defined in a unique way for the three-dimensional Schrödinger operator with complex finite potential. The behavior of quasi-levels in the case of analytical perturbation of potential is studied. For the first correction of the perturbation theory the analog of the secular equation is obtained. (auth)

24713 SECOND-QUANTIZATION REPRESENTATION FOR SYSTEMS OF ATOMS, NUCLEI, AND ELECTRONS. Girardeau, M. D. (Univ. of Oregon, Eugene). Phys. Rev. Lett.; 27: No. 21, 1416-19(22 Nov 1971).

A many-atom representation was derived in which bound atoms or molecules are described by elementary Bose or Fermi operators, the field operators for nuclei and electrons referring only to unbound particles. The Hamiltonian thus obtained contains not only nucleus-nucleus, electron-electron, and nucleus-electron Coulomb interactions, but also atom-atom, atom-nucleus, and atom-electron Coulomb and exchange interactions, including breakup and recombination terms. (auth)

24714 NUMERICAL INVESTIGATION OF THE SCATTERING OF A SUBSTANCE WITH A HARD SURFACE UNDER THE INFLUENCE OF STRONG IRRADIATION EMISSION. Gusev, N. V.; Pyarnpii, A. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 4, 127-33(Jul-Aug 1971). (In Russian).

The scattering process depicts the gas dynamics of normally incident flux of radiation on a surface. In the general case three spatial variables and one time variable are involved; one of the spatial variables is eliminated by choosing the direction of the incidence as normal. Cylindrical coordinates are used in the solution of the problem, and a gas-dynamic approximation is applied to the dense region of the jet. It was recognized that the appearance of shock waves, nonequilibrium process, and certain other phenomena badly complicate the picture. (K.S.W.)

24715 TIME OF ARRIVAL OPERATOR. Razavy, M. (Univ. of Alberta, Edmonton). Can. J. Phys.; 49: No. 24, 3075-81(15 Dec 1971).

The problem of finding proper quantal operators for the time of arrival, when the source is at infinite distance from the detector, is investigated. It is shown that at least two Hermitian operators can be constructed which, in the Hilbert space of positive energy spectrum, are self-adjoint. The spectra of these operators are continuous and their eigenfunctions form an orthonormal set. (auth)

24716 COMMUTATOR AND ANTICOMMUTATOR GREEN'S FUNCTIONS, ZERO-FREQUENCY POLES, AND LONG-TIME CORRELATIONS. Bloomfield, Philip E. (City Coll., New York); Nafari, Nasser. Phys. Rev., A; 5: No. 2, 806-13(Feb 1972).

Previous studies of the commutator-type Green's functions are extended to the anticommutator type. The existence of an $\omega = 0$ pole in the latter but not former case is demonstrated. Its residue is simply related to the long-time behavior of the corresponding correlation function. (auth)

24717 CORRECTIONS TO THE VARIATIONAL GROUND STATE OF A CHARGED-BOSON GAS. Lee, Deok Kyo (Univ. of Kansas, Lawrence); Ree, Francis H. Phys. Rev., A; 5: No. 2, 814-20(Feb 1972).

The variational ground-state energy of a charged-boson gas, obtained previously for an intermediate density range using a Bijl-Dingle-Jastrow (BDJ) type of correlated trial wave function, is improved in two steps: application of the paired-phonon analysis for optimization of the variational description of the ground state in the BDJ function space, using the hypernetted-chain equation for the correlation function, and use of the improved liquid-structure function to evaluate the second-order perturbation correction generated by three-phonon components. The paired-phonon analysis yields quite small corrections to the ground-state properties including the energy and the liquid-structure function, and the perturbation corrections to the energy are also found to be very small. It is demonstrated that in the high-density limit the procedure yields the ground-state energy exact through second order in the density expansion. (auth)

24718 BOUND STATES OF ONE-DIMENSIONAL POTENTIAL. Ronveaux, A. (Univ. Notre-Dame de la Paix, Namur, Belgium). Lett. Nuovo Cim.; 3: No. 5, 179-82(29 Jan 1972).

In one dimension a zero wave function at the origin (and on the negative axis) is interpreted as due to the presence of an infinite potential in that region. The conditions that a central potential support some given bound state are well known; and these conditions are, therefore, applicable to a one-dimensional potential surrounded by an infinite step. In this paper some of these conditions are extended to the more general case of a finite surrounding potential. (R.W.R.)

24719 EXACT RESULTS FOR A QUANTUM MANY-BODY PROBLEM IN ONE DIMENSION. II. Sutherland, Bill (Univ. of Utah, Salt Lake City). Phys. Rev., A; 5: No. 3, 1372-6(Mar 1972).

A previous investigation of the properties of a system of either fermions or bosons interacting in one dimension by a two-body potential $V(r) = g/r^2$ with periodic boundary conditions is continued. A method is introduced which provides a physically intuitive description of the excited states. The energies are given explicitly for finite and infinite systems, including all corrections due to quasiparticle interaction. The method is shown to apply to other one-dimensional systems as well. In particular, the results are applied to a classical one-dimensional N-body model of Dyson—the Coulomb gas in a Brownian medium. (auth)

24720 CONSTRUCTION OF BOUND-STATE SOLUTIONS TO THE SCHROEDINGER EQUATION WITH A YUKAWA POTENTIAL BY MEANS OF INTEGRAL EQUATIONS. Enflo, B. O. (Univ. of Stockholm). Phys. Scr.; 4: No. 1-2, 11-13(1971).

Convergent expansions of the radial wave functions and energy eigenvalue conditions for a particle bound by a Yukawa-like potential are given for all angular momenta. They are constructed by utilizing the Schrödinger integral equation in momentum space

and especially its information about the analytical structure of the Hankel transformed wave function. (auth) (Sweden)

24721 CONDITIONS ON THE ONE-MATRIX FOR THREE-BODY FERMION WAVEFUNCTIONS WITH ONE-RANK EQUAL TO SIX. Borland, R. E.; Dennis, K. (National Physical Lab., Teddington, Eng.). J. Phys., B (London); 5: No. 1, 7-15(Jan 1972).

The necessary and sufficient conditions for a one-body reduced density matrix of rank 6 to be derivable from a three-body fermion wave function are presented. For this case it can be shown explicitly that the information content of the one-matrix is less than that of the wave function. The extension of these conditions to the cases of a three-body function of one rank 7 and a four-body function of one-rank 8 is also discussed. Sufficient conditions were obtained for these two cases. Numerical studies reported lead to the belief that these conditions are the necessary and sufficient conditions. (auth)

24722 EQUIVALENT TWO-BODY INTERACTIONS WITH SPECIFIED BOUND-STATE WAVE FUNCTIONS. Girardeau, M. D.; Wannier, G. H. (Univ. of Oregon, Eugene). Phys. Rev., C; 5: No. 3, 1140-2(Mar 1972).

The correspondence between the recent Letter of the same title by Monahan, Shakin, and Thaler [Phys. Rev. Lett., 27: 518(1971)] and the method of "completely orthogonalized plane waves" is pointed out, and the geometrical significance of the corresponding transformation is elucidated. The analysis of Monahan, Shakin, and Thaler is generalized and simplified. (auth)

24723 DERIVATION OF THE SCHROEDINGER EQUATION FROM NEWTONIAN MECHANICS. Alonso, J.; Nieto, M. Paz; Santos, E. (Univ., Valladolid, Spain). Phys. Lett.; 38A: No. 7, 501-2(27 Mar 1972).

It is shown that the Schroedinger equation cannot be derived from the hypothesis that the motion of the particles is the composition of a Brownian motion and the motion that predicts Newtonian mechanics. (auth)

24724 THEORY OF A CHARGED BOSON GAS USING THE RANDOM-PHASE APPROXIMATION. Lee, J. C. (Northwestern State Univ. of Louisiana, Natchitoches). Phys. Rev., A; 5: No. 4, 1925-8(Apr 1972).

The Brandow boson many-body theory is used to calculate the generalized dielectric constant within the random-phase approximation. The generalized dielectric constant obtained this way agrees with the Bogoliubov theory in the high-density limit and thus yields all of the well known Bogoliubov results. The momentum distribution function for $\vec{k} \neq 0$ is also calculated. The treatment is fully number conserving. (auth)

24725 STOCHASTIC AND ADIABATIC BEHAVIOR OF PARTICLES ACCELERATED BY PERIODIC FORCES. Lieberman, M. A.; Lichtenberg, A. J. (Univ. of California, Berkeley). Phys. Rev., A; 5: No. 4, 1852-66(Apr 1972).

The mechanism by which periodic nonrandom forces lead to stochastic acceleration of particles is examined. Two examples considered are the Fermi problem of a ball bouncing between a fixed and an oscillating wall, with various wall-oscillation functions, and cyclotron-resonance heating in a magnetic mirror. Numerical studies show that the phase plane consists of a complicated but regular structure of islands embedded in a stochastic sea. These islands may have the character of either adiabatic barriers or sinks for particles. The islands can be described analytically by expansions about elliptic singular points. A velocity below which no islands exist is observed computationally and is predicted from Floquet theory. Computations also demonstrate that in some cases an adiabatic wall forms an upper limit to particle diffusion in velocity space. A lower bound on this wall is predicted analytically. The Fermi problem is reduced to a Hamiltonian form, and the nonlinear stability and approximate location of the adiabatic wall is predicted from adiabatic invariance theory. Introduction of an external random-force component modifies, but does not destroy, the basic results. For velocities below which no islands exist, it is shown that the random-phase assumption holds, and that the particle motion can be described by a Fokker–Planck equation. The solution to the Fokker–Planck equation is found to agree with the numerical calculations. Above the stochastic transition velocity, strong phase correlations exist, and a Fokker–Planck description is inappropriate. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 22600, 22693, 22759, 22761, 23216, 23267, 23308, and 24932–24935.

24726 (AECL–3911) THE AECL SYMPOSIUM ON ENGINEERING DEVELOPMENT IN NUCLEAR POWER HELD AT THE CHALK RIVER NUCLEAR LABORATORIES ON MAY 27–28, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971. 84p. (CONF-710530). AECL $2.00.

Eleven papers and a panel session, covering various aspects of nuclear engineering, are included. A separate abstract was prepared for each paper. No abstract was prepared for the panel session on "The Role of University Engineering Departments in Nuclear Power." (Canada)

For abstracts of individual papers see: 22690, 22934, 23286, 23436, 24727–24731, 24748, and 24761.

24727 (AECL–3911, pp 1-4) ELECTRICAL POWER IN CANADA'S FUTURE. Cheesman, W. J. (Canadian Westinghouse Co., Ltd., Hamilton (Ontario)). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

The growth in expected demand for various kinds of energy in Canada is discussed, based on a National Energy Board study. Forecasts are made for installed nuclear generating plants to the year 2000. Effects on investment and employment are considered, and the importance of public acceptance of nuclear plants is discussed. (Canada)

24728 (AECL–3911, pp 5-8) NUCLEAR POWER IN THE NEXT DECADE AND AECL'S PROGRAM TO MEET IT. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

The nuclear power generating capacity operating and under construction in Canada exceeds 50% of the current generating capacity of all other power plants in Ontario. In the remainder of this decade, the additional nuclear capacity expected to be committed in Canada is more than twice that already committed. The total value of these installations will exceed 5 billion dollars. There will be continued pressure to make the generation of energy cheaper, cleaner, safer, more reliable, and thriftier in the consumption of natural resources. The emphasis for some years will concern: (1) capital cost reductions; (2) improvement in reliability; (3) development of alternative fuels; (4) development of sources of nuclear materials and equipment; (5) performance of material, equipment and fuels in abnormal conditions; (6) reduction in the effect of activation of corrosion and wear products; and (7) increasing ability to assure the public that nuclear plants are acceptably safe and "clean." Although it can be assumed with confidence that the CANDU type plant can continue to be a success technically and economically, neither the domestic nor any export market is reserved for CANDUs. There are problems yet to be solved and problems yet to be experienced. (auth) (Canada)

24729 (AECL–3911, pp 19-26) MECHANICAL ENGINEERING RESEARCH AND DEVELOPMENT IN AECL. Hart, A. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

Mechanical engineering research and development in AECL is carried out at the Whiteshell Nuclear Research Establishment, at Power Projects, Sheridan Park, and at the Chalk River Laboratories. Some typical activities at each site are described. At Whiteshell: development work is proceeding on the applicability of holographic-interferometry to high-temperature displacement measurements; and in heat exchanger development, computer programs were developed capable of evaluating complex turbine cycles. At Power Projects: automatic tube welders have been developed for portable field use; and testing is carried out on the poison injection system for the Bruce reactors. At Chalk River: current activities include a valve-steam seal development program; use of small computers for data storage, retrieval and analysis problems; and analysis of reliability and maintainability of equipment and systems in nuclear power stations. (Canada)

24730 (AECL–3911, pp 41-5) CHEMICAL ENGINEER'S ROLE IN NUCLEAR-POWER-REACTOR DESIGN, DEVELOPMENT AND OPERATION. Hatcher, S. R. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

The most important chemical problems in nuclear reactors are decomposition of the coolant, corrosion of system materials, formation of films on heat transfer surfaces, and the production and transport of radioactivity around the coolant systems. These problems are common to all reactors whether the coolant is water, gas, an organic liquid or a molten metal. The development chemical engineer plays an essential role in the selection of the coolant to minimize these problems. The successful performance of a nuclear reactor depends upon good chemistry control. This requires a well executed chemical engineering development program to identify chemical problems and to establish chemical specifications and the means of control. In turn, process designers must take the design data from the development engineers and produce a system design which is operable, maintainable, and economic. Most important, the operators must recognize the importance of chemical control to the station performance, and must ensure that the reactor is operated within the chemical specifications. Chemical evaluation of station performance and feedback to designers and development engineers is essential. (auth) (Canada)

24731 (AECL–3911, pp 55-9) FUTURE REACTOR DESIGN CRITERIA AND HOW THEY CAN BE MET. Pon, G. A. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

In the future, the performance of all reactor concepts will be improved. To continue to meet the competition, the CANDU concept must be developed further. Various areas of performance improvement are identified, with reliability of equipment emphasized. Design for certain postulated accidents has added complexity and cost to the plant, and it is expected that safety requirements will become more severe. The solution is to reduce the possible frequency, severity and consequences of these accidents. Some safety problems are discussed and work required to alleviate them is suggested. In many instances, plants, both nuclear and fossil, have not been built to schedule or budget. The management of large projects is discussed and suggestions for improvement are indicated. (auth) (Canada)

24732 (ORNL–4728) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending August 31, 1971. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 229p. Dep. NTIS.

Research and development progress is summarized in four parts. A separate abstract was prepared for each part. (J.R.D.)

For abstracts of individual sections see: 22600, 22693, 23267, and 24754.

24733 (RDT-F-1-2-T(3-72)) PREPARATION OF SYSTEM DESIGN DESCRIPTIONS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 19p. RSO.

The purpose, scope, organization, and content of reactor system design descriptions are specified, in order to promulgate a unified approach to their preparation and use by a project as the principal means to establish, describe, and control the individual system designs from conception and throughout the lifetime of the system. (auth)

24734 REAKTORY ATOMNYKH ELEKTROSTANTSII. (Reactors at Atomic Electric Power Stations). Krasin, A. K. Minsk; Izdatel'stvo Nauka i Tekhnika (1971). 144p.

An analysis and classification of the world's electric generators which are nuclear powered are presented. The basic specifications are presented for typical water-cooled reactors, boiling water types, water-moderated designs, and heavy water reactors. Specific reactors which employ superheated steam are described, but particular attention is focussed on reactors with gaseous coolants and fast neutron reactors, respectively. 301 references. (K.S.W.)

24735 ATOMIC POWER PLANTS AND DEVELOPMENT OF ELECTRIC POWER INDUSTRY IN THE UKRAINIAN SOVIET SOCIALIST REPUBLIC. Yakusha, G. B. Energ. Elek.; No. 1, 41-3(Jan 1970). (In Russian).

24736 GAS COOLED FAST NUCLEAR REACTOR. Hooper, Alan Thomas; May, William Charles (to United Kingdom Atomic Energy Authority). British Patent 1,259,927. 12 Jan 1972. Filed 11 Feb 1970.

In the system described the reactor and heat exchangers are located in a prestressed concrete pressure vessel and are sepa-

rated from one another by a shield wall having passages for the interflow of coolant between core and heat exchanger; the passage for hot gas from the core contains a filter of refractory material. The wall may be a composite construction of water-cooled graphite blocks supporting a filter of dense honeycomb structure capable of taking the full flow of gas coolant issuing from the core. Provision may be made for access to the heat exchangers. All vessel penetrations above a critical size may be double contained, by critical size being meant that cross-sectional area through which coolant discharge could occur at a rate that would have a deleterious effect on the vessel internals. (UK)

24737 GAS COOLED FAST BREEDER REACTOR DESIGNS. PART 2. PERFORMANCE STUDIES OF LARGE GCFR PLANTS. Dee, J. B.; Melese-d'Hospital, G. B. (Gulf General Atomic Co., San Diego, Calif.). Mech. Eng.; 94: No. 2, 28-31(Feb 1972).

Results of parametric studies of GCFR designs are presented and compared to performance parameters of LMFBR designs. The effect of fuel enrichment on GCFR design and performance is examined. (13 references) (H.D.R.)

24738 PROCEEDINGS OF THE AMERICAN POWER CONFERENCE. VOLUME 33. Meeting Held at Chicago, April 20–22, (1971). Chicago; American Power Conference (1971). 1221p. $15.00. (CONF-710427).

Included are 131 papers on the overall aspects of generation, transmission, distribution, and utilization of power. A separate abstract was prepared for each of 41 papers dealing with nuclear power plants. (H.D.R.)

For abstracts of individual papers see: 22694, 22704–22705, 24204, 24552, 24739–24746, 24767–24768, 24778–24782, 24801–24806, 24812–24815, 24823–24824, 24827, 24832–24833, 24864–24868, and 24914.

24739 PANEL DISCUSSION. THE FAST BREEDER PROGRAM: THE ACTIONS REQUIRED BY THE POWER INDUSTRY. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf.; 33: 48-64(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The views of industry and government representatives on the work necessary to achieve the Liquid Metal Fast Breeder Reactor demonstration plant are presented. (H.D.R.)

24740 DESCRIPTION OF 350-MWe LIQUID-METAL FAST BREEDER DEMONSTRATION PLANT. Fidrych, L. F. (General Electric Co., Sunnyvale, Calif.). Proc. Amer. Power Conf.; 33: 87-97(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Preliminary design features of the LMFBR demonstration plant are presented. The scope of the LMFBR development and test program is discussed. (H.D.R.)

24741 300-MWe GAS-COOLED FAST BREEDER REACTOR DEMONSTRATION PLANT. Thomas, William N. (Virginia Electric and Power Co., Richmond); Simon, Robert H. Proc. Amer. Power Conf.; 33: 98-106(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The performance potential for helium cooled fast breeders is compared to LMFBR designs. Design parameters are presented for a 300 MW(e) GCFR demonstration plant. (8 references) (H.D.R.)

24742 WESTINGHOUSE LIQUID-METAL FAST BREEDER REACTOR DEMONSTRATION PLANT DESIGN. Jacobi, W. M. (Westinghouse Electric Corp., Madison, Pa.). Contract AT(30-1)-4200. Proc. Amer. Power Conf.; 33: 107-26(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The basic design parameters of the 330 MW(e) LMFBR demonstration plant are presented and the plant program schedule is described. (H.D.R.)

24743 ATOMICS INTERNATIONAL LMFBR DEMONSTRATION PLANT. Beeley, R. J.; Ash, E. B. (Atomics International, Canoga Park, Calif.). Proc. Amer. Power Conf.; 33: 127-35 (1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The LMFBR demonstration plant objectives, design features of a 500 MW(e) plant, and the status of the associated testing program are summarized. (H.D.R.)

24744 UNDERGROUND NUCLEAR POWER PLANTS: ENVIRONMENTAL AND ECONOMIC CONSIDERATIONS. Rogers, Franklyn C. (Harza Engineering Co., Chicago). Proc. Amer. Power Conf.; 33: 166-74(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24745 POSSIBLE SOLUTIONS FOR EMISSION CONTROL. Brant, Victor L.; Stotko, Norbert A. (Stearns-Roger Corp., Denver). Proc. Amer. Power Conf.; 33: 594-601(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24746 THE GENERATION GAP. Swengal, F. M. (Stanley Consultants, Muscatine, Iowa). Proc. Amer. Power Conf.; 33: 916-23(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Planning, construction, and economic aspects of the electric power industry, differences in actual power generating capacity, and the generating capacity needed are discussed. (H.D.R.)

24747 BED NUCLEAR REACTOR. Hilborn, John W.; Lennox, Colin G.; Mathers, Wilson G. (to United States Atomic Energy Commission). U. S. Patent 3,620,916. 16 Nov 1971. Filed 21 Apr 1969.

A cavity-type reactor reactor moderated by a heavy water reflector-moderator in an outer shell is described. The reactor is contained in a core shell which is fitted with a hollow inverted liner spaced from the core shell to form an annular passageway down which incoming feed water is passed. Fuel inside the liner generates steam that passes out through the top of the shells. (Official Gazette)

Physics and Core Engineering

Refer also to abstract 25028.

24748 (AECL–3911, pp 9-18) STATUS OF HEAT-TRANSFER AND FLUID-DYNAMICS RESEARCH RELATED TO THE CANDU POWER-REACTOR PROGRAM. McPherson, G. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

Heat transfer and fluid dynamics research in support of Canada's pressurized and boiling water cooled, heavy water moderated power reactors is surveyed. In the case of pressurized coolant the fuel may be power limited by the critical heat flux causing dryout at low coolant qualities. In the case of boiling coolant the average coolant quality is much higher and both dryout and parallel channel flow instability may be limiting. In both cases, the booster rods, used to provide reactivity for short periods, may be limited by the critical heat flux causing departure from subcooled nucleate boiling. At Chalk River, research in this field is aimed at improving the prediction of conditions leading to dryout, departure from subcooled nucleate boiling, flow instability and post dryout heat transfer in multi-element fuel bundles. Besides ad-hoc testing of specific bundle geometries the program involves more basic research in support of a computer code for the prediction of subchannel coolant conditions. Safety considerations have led to a growing experimental program in support of transient and accident analysis. (20 references) (auth) (Canada)

24749 (AI-AEC–13019) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, October–December 1971. (Atomics International, Canoga Park, Calif.). 15 Feb 1971. Contract AT(04-3)-824. 43p. Dep. NTIS.

CRITICAL ASSEMBLIES—physics parameters of fast benchmark cores in, (E/T)
—neutron importance distribution in ECEL, axial fission, (E/T)
—core for ECEL, composition of mockup sodium cooled fast
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during October to December 1971
—blankets for, neutron flux spectra through lower axial, (T)
NEUTRON CROSS SECTIONS—calculations for fast assemblies, evaluation of ENDF/B data for, (E/T)
PLUTONIUM 239—neutron cross sections in fast reactor spectra, Monte Carlo method analysis of
REACTORS, FAST—physics calculations for, development of VIM computer program for
TUNGSTEN—neutron cross sections for, evaluation of ENDF/B data for, (E/T)
URANIUM 235—neutron cross sections for, evaluation of ENDF/B data for, (E/T)
URANIUM 238—neutron cross sections in fast reactor spectra, Monte Carlo method analysis of (H.D.R.)

24750 (BARC/I–116) WATER CHEMISTRY STUDIES. V. pH REACTIVITY EFFECT IN WATER COOLED REACTORS. Mathur, P. K.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 6p. INIS.

Literature on the pH reactivity effect in water cooled reactors is reviewed. A variation in the reactivity is observed with a variation of alkali concentration in the primary coolant i.e., a variation in its pH. The magnitude of the effect is different for different reactors and is significant only in reactors operating at power. Several possible mechanisms put forward to explain the effect are discussed. It is indicated that the use of the pH effect in the long term control of reactors can lead to an improved economy in future. (INIS)

24751 (DP–1284) HERESY III COMPUTER CODE. Finch, D. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb 1972. Contract AT(07-2)-1. 81p. Dep. NTIS.

The Heresy III computer code is a general-purpose two-dimensional reactor code based on the diffusion theory source-sink formalism developed by S. M. Feinberg. The code is applicable to calculations of reactivity, control rod worth, power ratios, and other similar calculations for heavy-water- and graphite-moderated reactors. Options within the code permit a variety of criticality searches to be performed. A derivation of the theory on which the code is based is presented. A description of the features of the code and their use is included. The input and output required for use of the code are listed. (15 references) (auth)

24752 (JPRS–55303) EFFECT OF THE INITIAL GAS TEMPERATURE ON THE PARAMETERS AND THERMAL EFFICIENCY OF NUCLEAR STEAM-AND-GAS INSTALLATIONS. Ratnikov, E. F. Translated from Izv. Vyssh. Ucheb. Zaved., Energ.; No. 12, 63-8(Dec 1971). 8p. NTIS.

24753 (ORNL–4674) REACTIVITY BALANCE CALCULATIONS AND LONG-TERM REACTIVITY BEHAVIOR WITH ^{235}U IN THE MSRE. Prince, B. E.; Engel, J. R.; Gabbard, C. H. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 104p. Dep. NTIS.

Reactivity trends in the Molten-Salt Reactor Experiment were studied from the beginning of power operation by comparing predicted effects of changes in the core conditions with observed compensating effects associated with control rod motion. The calculations were made on-line, during operation by using an available digital-computer data logger. The changes accounted for included uranium depletions and additions; plutonium production; ^{135}Xe, samarium, and other fission product production; temperature variations; and burnout of residual ^{6}Li and ^{10}B (in graphite). The entire period of operation with ^{235}U in the fuel salt was studied. 40 references. (auth)

24754 (ORNL–4728, pp 1-44) MSBR DESIGN AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Feb 1972.

In Molten-Salt Reactor Program.

BOILERS—design parameters of molten salt breeder reactor
GRAPHITE—lifetime calculations for molten salt breeder reactor moderator
HEAT EXCHANGERS—failure of tubing in molten salt breeder reactor, analysis of coolant and fuel mixing from
MOLTEN SALT BREEDER EXPERIMENT—core for, power and neutron flux distributions in
—moderator for, lifetime calculations for graphite
MOLTEN SALT BREEDER REACTOR—design parameters of 300 MW(e) demonstration, conceptual
—core structure for 300 MW(e) demonstration, conceptual design parameters of
—tanks for 300 MW(e) demonstration, conceptual design parameters of fuel salt drain
—heat exchanger tubing for, analysis of coolant and fuel mixing from failure of
—physics calculations for
—fuel cycle for, physics calculations for optimum economic
—radioactive waste disposal system for, design requirements for off-gas
—fuel salt for, gas bubbles in
—boilers for, design parameters for
—pumps for, performance of coolant salt
—control system for, development of
—fuel salt for, heat transfer characteristics of
PUMPS—performance of coolant salt, for molten salt breeder reactors
RADIOACTIVE WASTE—disposal system for off-gas, for molten salt breeder reactors
REACTOR CONTROL SYSTEMS—development of molten salt breeder reactor
REACTOR FUELS—cycle management economics for molten salt breeder reactor (D.C.C.)

24755 (RT/ING–(71)16) SOME APPLICATIONS OF THE VARIATIONAL METHOD. Krajewski, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 18 Oct 1971. 28p. Dep. NTIS (U. S. Sales Only).

A variational method analysis of thermal hydraulics for a liquid metal cooled reactor core is presented. 7 references. (D.C.C.)

24756 (RT/ING–(71)17) FRETA (FAST REACTOR THERMAL ANALYSIS). IBM 7094 PROGRAM FOR CALCULATION OF THE THERMAL PROFILE IN A FUEL ROD OF A FAST REACTOR. Dominici, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28 Oct 1971. 29p. (In Italian). Dep. NTIS (U. S. Sales Only).

FRETA, an IBM 7094 code written in FORTRAN IV, allows the calculation of the steady state thermal radial profile in the fuel pins of a fast reactor. The requested input data are: the linear power, the coolant temperature, the pin geometry, the fuel density and the thermal coefficients. The adopted physical model takes into account, schematically, the densification of the fuel internal zone. (4 references) (auth)

24757 (UJV–2501-RT) HYDRODYNAMICS AND THERMOKINETICS IN TUBULAR CHANNELS WITH LONGITUDINAL FINS. Cervenka, J.; Hejna, J.; Malak, J.; Reznicek, M.; Stibor, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb 1971. 35p. (In Czech). INIS.

An air loop is described in which the hydrodynamics and thermokinetics of tubular channels with longitudinal fins were studied as part of research into divided tubular fuel elements for a heavy-water gas-cooled power reactor with natural uranium. Hydrodynamic and thermokinetic studies were performed on 24 and 16 models, respectively, which differed by the inner tube diameter and by the fin pitch and height. The fins were rectangular with a constant width of approximately 1.2 mm. A brief description is also given of measurement of the basic parameters: temperature, pressure, flow rate and electrical output of heating, and the methods of processing the experimental data. (INIS)

24758 PHYSICAL PROPERTIES OF THE ONCE THROUGH THEN OUT PEBBLE-BED REACTOR. Hansen, U.; Schulten, R.; Teuchert, E. (Kernforschungsanlage, Juelich, Ger.). Nucl. Sci. Eng.; 47: No. 1, 132-9(Jan 1972).

A new and promising operating modus for the pebble-bed reactor was investigated. Instead of circulating the fuel balls several times through the core they are moved only once slowly from the top to the bottom. Due to the increasing depletion toward the lower core area, there is a substantial axial tilt of the power density, and the downward flow of the cooling gas ensures for the system an optimal heat removal. The reduced power generation in the hot core area and the absence of hot spots enable achievement of a higher power density than in the known pebble-bed type and make possible a rise in the average gas outlet temperature up to 950°C. For a UO_2-fueled reactor the life history is followed for several years by means of a two-dimensional calculation approach. Apart from the advantages in thermodynamics, the new system is marked by a very short and smooth running-in period, by a high sensibility of reactivity to control poison changes inside the upper reflector, and by an ideal accommodation of the burnup in the balls running with different flow speeds in different radial positions. The spatial distribution of the power density can be flexibly manipulated by changes in the fuel cycle speed, in fuel ball layout, or by the use of a higher feed enrichment in the outer core region. A brief parameter study and a discussion of technological aspects give an outline of the developing potential of that new type. (auth)

24759 REPRODUCIBILITY OF THE PARALLEL-FLOW INDUCED VIBRATION OF FUEL PINS. Kadlec, J. (Kernforschungszentrum, Karlsruhe, Ger.); Ohlmer, E. Nucl. Eng. Des.; 17: No. 3, 355-60(1971).

The influence of the test loop on parallel-flow-induced vibration of fuel pins of the Na 1 fast reactor design was investigated. The experiments were performed with the same subassembly mock-up, mounted in the test section of four different flow loops with several modifications. In spite of a broad variation of the level (1 : 10) and the structure of pressure fluctuations at the water inlet into the subassembly, only moderate scatter (±50%) of the level and a slight variation of the structure of the vibrating response of the pins were observed. Experimental results are presented in the form of diagrams of normalized rms-values of pressure fluctuations and vibration strains plotted over the Reynolds number. The structure of pressure fluctuations and vibration strains is illustrated by several typical spectral density plots. (auth)

24760 FORCED CONVECTION HEAT TRANSFER FOR PARALLEL FLOW THROUGH A ROUGHENED ROD CLUSTER. Walker, V. (Univ. of Bradford, Eng.); White, L.; Burnett, P. Int. J. Heat Mass Transfer; 15: No. 3, 403-24(Mar 1972).

For advanced gas-cooled reactors, methods are required for detailed, accurate estimating of the temperature distribution over the cladding of the cluster fuel elements. The formulation of a temperature calculation procedure embodied in a computer pro-

gram, HOTSPOT, is described. The fuel channel power distribution and coolant flow rate are specified, and, step by step along the channel, determinations are made of the flow distribution among the cluster sub-channels, the mean coolant temperature in each sub-channel, with an allowance for heat exchange between adjacent sub-channels, and the local cladding-coolant temperature differences. A description is given of the design, execution and analysis of a major experiment to test the calculation procedure. The experiment involved a 15 ft long cluster of 36 roughened rods, with electrical resistance heating of 900 kW, the distribution of which could be controlled, and with more than 600 thermocouples installed to determine the temperature distribution. (auth) (UK)

Control and Instrumentation

24761 (AECL-3911, pp 61-6) INSTRUMENTATION AND CONTROL. Pearson, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs). Nov 1971.

From Symposium on engineering development in nuclear power; Chalk River, Ontario (27 May 1971).

Instrumentation and control development in support of the nuclear power program emphasizes three areas: reactor instrumentation, power plant modelling, and control system concepts. Effort in reactor instrumentation deals mainly with basic sensing problems. Measurement of the power distribution throughout a reactor, detection of small amounts of heavy water either in light water or in air, and the detection and location of failed fuel elements with a reactor core, are problems under intensive study. To complement this sensor development, support is available for the development of complete measurement systems. Power plant modelling is centered around the Advanced Boiling Light Water (ABLW) program under way at CRNL. As power plants become larger interaction of their various parts must be better understood. To do this detailed modelling of complete power stations is becoming necessary and furthermore to ensure that such models are realistic methods are being developed for measuring the dynamic performance of operating plants. Many of the schemes now being used in the nuclear power program were first tried on a large research reactor at CRNL. The process of evolution continues, but more and more it appears that analog models will have to serve as vehicles for testing new control algorithm and more generally for the testing of new overall system arrangements. (auth) (Canada)

24762 (KFK-1452) JACKET INSPECTION ON FUEL ELEMENTS OF NUCLEAR REACTORS. Jacobi, S.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Oct 1971. 10p. (In German). Dep. NTIS (U. S. Sales Only).

After an introduction to the problems of release of fission products and of nuclear fuel into the coolant, the working method of control devices is explained. For water-cooled reactors the method of precipitation of solid fission products is described. At sodium-cooled reactors the relative low activity of the fission products must be discriminated against the very high activity of the sodium. This is only possible by means of the delayed neutron emission of some fission products. (12 references) (auth)

24763 NUCLEAR CONTROL ROOM OF THE 1980s. Scheideler, A. L. Power Eng.; 76: No. 2, 48-50(Feb 1972).

The hypothetical 1980 nuclear power plant control room is discussed. Advances in technology and design will allow the control room to be smaller and simpler, with new displays, new circuitry, and new operator procedures. Control modules will be factory pre-assembled and tested and the equipment will include built-in simulators. (H.D.R.)

24764 SYSTEM AND METHOD FOR OPERATING A BOILING WATER REACTOR-STEAM TURBINE PLANT. Podolsky, Leaman B. (to Westinghouse Electric Corp.). U. S. Patent 3,630,839. 28 Dec 1971. Filed 26 Nov 1968.

A turbine follow control system for a boiling water reactor-steam turbine plant includes an electrical reference system which determines the reactor operating level through a reactor control system. The turbine follow control system operates turbine steam valves and steam bypass valves electrohydraulically to control the steam throttle pressure as the level of reactor operation is controllably varied to produce required steam flow. In another arrangement, a coordinated control system for a boiling water reactor-steam turbine plant includes an electrical reference system which simultaneously determines the reactor operating level and the turbine steam flow subject to throttle pressure control constraints. (Official Gazette)

24765 CLOSED-CYCLE GAS TURBINE NUCLEAR POWERPLANT. Erlenbach, David Schmidt (to Sulzer Brothers Ltd.). U. S. Patent 3,629,060. 21 Dec 1971. Priority date 8 Nov 1967, Switzerland.

A gas turbine powerplant includes a nuclear source of heat, a gas turbine, a cooler, and a compressor connected into a closed cycle. A bypass is connected around the compressor, and a reservoir for the working substance is connected into the cycle through separately valved lines upstream and downstream of the compressor. A load or speed responsive regulator controls these lines, and also a valve in the bypass. Means are provided to generate a signal representative of the time rate of change of pressure in the cycle in the vicinity of the reactor, and this signal, when it exceeds a threshold value, controls operation of the regulator to limit the pressure variations of the working substance in the reactor. (Official Gazette)

Containment Systems, Waste Processing, and Radiation Protection

24766 METHODS AND DATA FOR REACTOR SHIELD CALCULATIONS. Clark, Francis H. (Oak Ridge National Lab., Tenn.). Advan. Nucl. Sci. Technol.; 5: 95-183(1969).

Shield calculation methods are described and the range of their applications and their limitations are reviewed. The calculations are discussed on the basis of the method and on the basis of the nature of the problem. Specific topics include: spherical harmonics expansion and related methods, discrete ordinates, removal cross section, transport-slowing down, multigroup calculations, moments method, gamma-ray buildup factors, neutron attenuation curves for fission sources, geometric transformations, Monte Carlo calculations, albedo, ducts and voids, and secondary gamma-ray dose. (186 references) (H.D.R.)

24767 PWR NUCLEAR POWER PLANT SYSTEMS FOR REDUCING RADIOACTIVE RELEASES. Von Hollen, H. J.; Webb, W. A. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 33: 145-53(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24768 NUCLEAR PLANT ENVIRONMENTAL CONTROL. Smith, James M.; Kent, Clifford E. (General Electric Co., San Jose, Calif.). Proc. Amer. Power Conf.; 33: 154-65(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Design objectives, operating experience, and plant designs for control of effluents from boiling water reactors are reviewed. Future design requirements are discussed. (H.D.R.)

24769 NONLINEAR SEISMIC RESPONSE OF A REINFORCED CONCRETE NUCLEAR REACTOR CONTAINMENT VESSEL. Citerley, Richard L. (Anamet Labs., Inc., San Carlos, Calif.); Ball, Robert E. Nucl. Eng. Des.; 17: No. 3, 341-4(1971).

The geometrical nonlinear, dynamic response of a reinforced concrete shell of revolution subjected to a horizontal acceleration at the base is examined. The results from a numerical example indicate that the nonlinear effects are negligible and motion in the ovalling mode of the vessel is insignificant. (9 references) (auth)

24770 PRESSURE-TEMPERATURE TRANSIENTS FOR CONTAINMENT DESIGN OF WATER-COOLED REACTORS. Mesarovic, Miodrag; Gaberscek, Boris (ENERGOPROJEKT, Belgrade). Nucl. Eng. Des.; 17: No. 3, 428-38(1971).

The containment structure design requirements for water-cooled reactors were evaluated from the mass, volume and energy balance equations representing the blowdown phase of a loss of coolant accident. Thermal equilibrium, both with and without water separation, as well as nonequilibrium conditions, were assumed. Numerical solutions are shown which demonstrate the application of the model and the influence of various assumptions and approximations. (auth)

24771 ADSORBENTS FOR RADIOIODINE REMOVAL AT NUCLEAR POWER PLANTS. Hladky, Eduard; Pietrik, Ivan; Kubik, Igor (Power Research Inst., Jaslovske Bohunice, Czech.). Jad. Energ.; 18: No. 1, 18-22(Jan 1972). (In Czech).

A brief survey is given of modern methods of radioiodine removal at nuclear power plants. The possibility of utilizing inorganic sorbents for this purpose was investigated. The absorbents considered included alumina, and $AgNO_3$. The sorbent capacity of each was measured. The effectiveness of iodine and methyl iodide capture was studied as functions of temperature, sorbent support properties, the concentration of radiodine and methyl iodide, and contact time. The results indicate that the given adsorbents are to be utilized as an iodine filter and also in the detection of iodine. 20 references. (tr-auth)

24772 EXPERIENCES AND PROBLEMS ON DESIGN AND CONSTRUCTION OF RADIATION SHIELDING. 4. RADIATION SHIELDING FOR FAST BREEDER REACTORS. Higashihara,

Yoshiharu (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 7, 400-8(Jul 1971). (In Japanese).

Characteristics of the fast breeder reactors and associated problems on design of radiation shielding are described. A detailed analysis was made on the design of Na-cooled fast breeder reactor plants from the standpoint of the radiation shielding, referring to results of experiences obtained by use of a prototype reactor "JOYO". Design methods of fast breeder reactors and problems to be solved are given. (Japan)

Coolant System

24773 (BAW-10037) REACTOR VESSEL MODEL FLOW TESTS. PART 1. FLOW DISTRIBUTION, PRESSURE DROP, AND GROSS MIXING. PART 2. VENT VALVE TESTS. Mullinax, B. S.; Walker, R. J. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Feb 1972. 60p.

Hydraulic tests on a one-sixth-scale model of a two-loop pressurized water reactor with 177 fuel assemblies are described. The following areas were investigated: core inlet and outlet flow distribution; vessel pressure drop; gross mixing of the fluid entering the core and within the core; and vent valve closing forces. Test results are presented. (auth)

24774 (IAEA-R-627-F) STRESS ANALYSIS AT HEAD-SHELL CONNECTIONS AND STRENGTH RESEARCH OF LARGE-DIAMETER SCREWS OF NUCLEAR POWER PRESSURE VESSELS. Final Report for the Period 1 July 1968-30 June 1970. Kuchta, J.; Stepanek, S. (International Atomic Energy Agency, Vienna (Austria)). Feb 1971. 93p. INIS.

A detailed theoretical stress analysis model is presented for a flanged joint on a reactor pressure vessel. A general method of calculation is presented. The calculation is converted into a program for a digital computer which permits a quick but detailed evaluation of structural or operating condition changes. An example calculation for a specific vessel is presented. (INIS)

24775 INSULATION MODULE WITH SUPERPOSED DEFORMED CORE SHEETS. Cremer, George D. (to United States Atomic Energy Commission). U. S. Patent 3,636,674. 25 Jan 1972. Filed 10 Aug 1964.

Insulation modules are described which have a core of relatively movable, flat and corrugated metal sheets assembled between opposed faceplates and which have deformable, seal-forming portions projecting beyond the faceplates. Methods of fabricating such modules and of forming them into modular insulation assemblies are outlined. (auth)

24776 STEAM-COOLED REACTOR. Germer, John H. (to General Electric Co.). U. S. Patent 3,634,189. 11 Jan 1972. Filed 26 Feb 1968.

A steam-cooled nuclear reactor system is disclosed. This system uses a steam-cooled reactor as the sole heat source and does not require the pumping of steam. Typically, saturated supply steam is directed through a reactor core where it is superheated, then through a heat exchanger to boil water to produce additional supply steam, then through the core again for resuperheating. This cycle may be repeated, with the superheated steam eventually being passed to a load, such as a turbine. (auth)

24777 SODIUM COOLING FOR FAST REACTORS. van der Laken, R. A. Atoomenergie Haar Toepass.; 13: 7-12(Jan 1971). (In Dutch).

In two aspects, one phase heat transfer and unstable boiling, the thermal hydraulic research on sodium cooled fast reactors differs essentially from research on water cooled reactors. It is important that more knowledge on superheat of liquid sodium is obtained in order to be able to describe the possible boiling modes in sodium cooled fast reactors. (auth) (Netherlands)

24778 CURRENT TRENDS IN THE CONTROL AND SURVEILLANCE OF PRESSURE VESSEL IRRADIATION EFFECTS. Chernock, W. P.; Koziol, J. J. (Combustion Engineering, Inc., Windsor, Conn.). Proc. Amer. Power Conf.; 33: 275-83(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24779 MODULAR STEAM GENERATOR FOR THE LMFBR POWER PLANTS. McDonald, J. S.; Casey, D. F.; Morgan, W. T. (North American Rockwell Corp., Canoga Park, Calif.). Proc. Amer. Power Conf.; 33: 284-93(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Design criteria for a modular sodium-heated steam generator are discussed. Studies leading to the selected design are described, and the development program for LMFBR demonstration plant units is examined. (H.D.R.)

24780 SAMPLING AND ANALYSIS PROCEDURES IN WATER REACTORS. Sawochka, S. G. (General Electric Co., San Jose, Calif.). Proc. Amer. Power Conf.; 33: 741-8(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

A survey is presented of utility sampling and analysis practices for feedwater, primary coolant, steam generator coolant, and makeup water in nuclear power plants. (H.D.R.)

24781 WATER REACTOR PLANT CONTAMINATION AND DECONTAMINATION REQUIREMENTS: A SURVEY. Charlesworth, D. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Proc. Amer. Power Conf.; 33: 749-56(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Results are summarized for a survey of water cooled reactor power plants to determine the importance of radiation fields from corrosion products to plant maintenance. (H.D.R.)

24782 NUCLEAR STEAM SUPPLY SYSTEM WATER CHEMISTRY RESEARCH. Hicks, J. H. (Babcock and Wilcox Co., Lynchburg, Va.); Mravich, N. J.; Pocock, F. J. Proc. Amer. Power Conf.; 33: 790-804(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The Babcock & Wilcox nuclear steam supply system uses a pressurized water reactor with chemical shim control and once-through steam generators. Research programs used to establish the water chemistry requirements of the system are discussed. (17 references) (H.D.R.)

24783 PRESSURIZED-WATER NUCLEAR REACTOR. Dotson, Erroll W.; Kidwell, John H.; Lindstrom, Gerald D. (to Babcock and Wilcox Co.). U. S. Patent 3,623,948. 30 Nov 1971. Filed 25 Apr 1968.

A pressurized-water nuclear reactor is described wherein the incoming relatively cool water entering the reactor is distributed for temperature equalization and controlled flow through the reactor core so as to minimize overheating of localized portions of the core. (Official Gazette)

24784 CLOSED FLUID SYSTEM PRESSURIZATION. Carlson, Roger D. (to United States Atomic Energy Commission). U. S. Patent 3,624,759. 30 Nov 1971. Filed 17 Feb 1970.

A closed fluid system is pressurized by using a fluid pump instead of a cover gas. In nuclear reactor closed fluid systems where the fluid is a liquid metal, electromagnetic pumps can be used. In addition, an electromagnetic pump which develops a high pressure gradient within the pump while maintaining the inlet and outlet pressures substantially equal can be used to separate gases from the fluid. (Official Gazette)

24785 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Heathcote, John; Cornell, Walter Ernest; Neve, Peter William; Bell, Alan (to Foster Wheeler John Brown Boilers Ltd.). British Patent 1,261,018. 19 Jan 1972. Filed 2 Feb 1968.

In conventionally fired power stations the problem of condensation in steam turbines is usually dealt with by removal of steam from an intermediate point in the turbine, before water droplets have formed, and returning it to the boiler for reheating. With such power stations there is available in the boiler a copious supply of very hot gases, but the problem is different in nuclear power stations where only a relatively low grade heating source is available, the problem being particularly acute in water reactors, where the steam supply to the turbines is only very slightly superheated. One way in which excessive condensation can be avoided is to reheat the steam at some intermediate stage in its passage through the turbines by subjecting it to heat exchange with live steam or a combination of live and bled steam. The live steam source can be divided into two, one part driving the turbines and the remainder being used to reheat the steam. The system described is based on a heat exchanger in which this reheating can be effected. Important advantages of the system are enumerated. (UK)

24786 PIPE-RUPTURE STUDY, 1971. Vandenberg, S. R. Nucl. Safety; 13: No. 2, 122-9(Mar-Apr 1972).

The pipe-rupture study is concerned with extending the understanding of failure-causing mechanisms and improving the capability for evaluating reactor piping systems to minimize the probability of failures. Following a detailed review to determine the effort most needed to improve nuclear system piping (phase I), analytical and experimental efforts (phase II) were started in 1965. The accomplishments are summarized in a broad program of at-reactor tests of the effect of primary coolant environment on the fatigue behavior of piping steels; fatigue studies through both bench-scale and large-component tests; fracture mechanics;

solution of problems in stress analysis; and failure-probability study of actual reactor piping systems. Broadly, the results obtained show that primary piping systems are very safe; that such piping is conservatively designed (to B31.7 Nuclear Piping Code); and that the materials, particularly in low-cycle fatigue, are such that considerable leeway exists on the side of safety, i.e., the number of stress cycles to initiate and grow cracks through pipe walls is at least an order of magnitude greater than the number of cycles in plant service lifetimes of 40 years. (auth)

Fuels and Fuel Elements

24787 (WCAP-7800) NUCLEAR FUEL DIVISION RELIABILITY AND QUALITY ASSURANCE PROGRAM PLAN. Molloy, J.; Bassler, E. A.; Kauffman, W. P. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 38p.

The quality assurance program provides for control over all activities affecting product quality, commencing with design and development of fuel assemblies and associated core components and continuing through procurement, materials handling, fabrication, testing and inspection, storage, and transportation. The program also provides for the indoctrination and training of personnel and for the auditing of activities affecting product quality through a formal auditing program. (auth)

24788 CONNECTOR ASSEMBLY. Kolb, Jack W.; Smith, Bob G. (to United States Atomic Energy Commission). U. S. Patent 3,635,793. 18 Jan 1972. Filed 7 Oct 1969.

A working member, particularly nuclear fuel, is held in place by a latched assembly. The latches are operated by a slidable sleeve working against a heavy spring. A pneumatic cylinder and piston pushes the slide against the spring, releasing the latches. The arrangement also compensates for creep or thermal expansion and, in one embodiment, relieves pressure surges. (auth)

24789 TRANSIENT EFFECT ON LMFBR FUEL RODS BY GAS BUBBLES ENTRAINED IN THE COOLANT. Carelli, Mario D.; Shoua, Ezra D. (Westinghouse Advanced Reactors Div., Madison, Pa.). Contract AT(30-1)-4135. Nucl. Eng. Des.; 17: No. 3, 322-8(1971).

The effect of the intermittent passage of gas bubbles entrained in the sodium coolant on the integrity of the fuel rod cladding is examined for typical conditions of liquid metal fast breeder reactors. The maximum stable size of the bubbles is calculated to be of the order of 0.5 in equivalent spherical diameter. The transient blanketing of the fuel rod due to the passage of the bubbles is studied for two extremely conservative geometrical configurations. The maximum calculated cladding temperature increase during the transient was found to be fairly limited, and the thermal fatigue effect due to the passage of a large number of bubbles was assessed. It appears that even in the most pessimistic conditions the fatigue effect is well below the failure limit. It was concluded, therefore, that gas bubbles flowing through the core do not endanger the cladding integrity and do not reduce the fuel rod lifetime. (12 references) (auth)

24790 FUEL SUBASSEMBLY FOR A NUCLEAR REACTOR. Worthington, Walston Chubb; Keller, Donald L.; Wullaert, Richard A.; Storhok, Victor W. (to United States Atomic Energy Commission). U. S. Patent 3,619,366. 9 Nov 1971. Filed 6 May 1969.

A fuel subassembly for a nuclear reactor incorporates a body of uranium dioxide or mixed uranium–plutonium dioxide fuel within an elongated casing. A gas plenum is located at the top and bottom of the subassembly and a metal tube or rod serving as a heat sink extends along the axis of the subassembly. (Official Gazette)

24791 PREDICTION OF MAXIMUM TEMPERATURE OR MELTING FRACTION IN A LMFBR FUEL ELEMENT. Thompson, D. H.; Marr, W. W. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 17: No. 3, 361-70(1971).

Thermal conductivity correlations, microstructure temperature boundaries, and related fuel densities are described for several mixed-oxide (UO_2–PuO_2) fuel-element models. Equations to apply these models to fast-reactor fuel elements are derived for both non-melting and melting conditions. These mixed-oxide fuel-element models are then utilized to calculate the maximum temperature in a liquid–metal fast-breeder reactor (LMFBR) fuel element. Sample calculations are performed for over-enriched mixed-oxide fuel elements that are inadvertently loaded into the center of a reactor core having characteristics similar to the fast flux test facility (FFTF). Weight fraction of molten fuel is calculated for operating conditions where the mixed-oxide fuel-melting temperature is exceeded. Results predicted by the various fuel-element models are shown to be in good agreement. (12 references) (auth)

24792 STABILITY OF CYLINDRICAL FUEL-ELEMENT CLADDING TAKING INTO ACCOUNT INITIAL ELLIPTICITY. Likhachev, Yu. I.; Popov, V. V. At. Energ. (USSR); 32: No. 1, 3-9(Jan 1972). (In Russian).

The solution is given of the cylindrical fuel element cladding stability problem under creep conditions taking into account the original ellipticity for pressures and temperatures varying during the period of operation. Accounted for in the solution is the effect on the loss of cladding stability of non-uniform swelling of steel, which may occur for large integral fluxes in fast reactors. The results are presented of calculations for austenitic-steel cladding for a gas-cooled reactor. (16 references) (auth)

Auxiliary Systems and Engineered Safeguards

Refer also to abstract 23429.

24793 (ANCR-1014) SEMISCALE BLOWDOWN AND EMERGENCY CORE COOLING (ECC) PROJECT TEST REPORT: TEST 845 (ECC INJECTION). Olson, D. J. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jan 1972. Contract AT(10-1)-1375. 67p. Dep. NTIS.

The results of a decompression experiment (Test 845) performed in the Semiscale Blowdown and Emergency Core Cooling (ECC) Project as a part of the Water Reactor Safety Program of the U. S. Atomic Energy Commission are presented. The data are intended to provide a basis for assessing and measuring the maturity of analytical codes used to predict the response of pressurized water reactors to decompression and ECC injection for a hypothetical major loss-of-coolant accident. The substantial and significant differences between a large nuclear reactor and the semiscale apparatus, and the differences in the related phenomenologies during postulated loss-of-coolant accidents, make invalid any direct extrapolation of the results from this test to a reactor. This test was intended only for purposes of analysis methods development and evaluation. Semiscale Test 845 was initiated by a cold leg (inlet piping) break of a system that includes both a single operating loop and a vessel with a simulated (electrically heated) reactor core, and was the first semiscale test in which ECC was injected. The objective of this test was to obtain initial experimental information relative to the effects of ECC injection on cooling fluid availability to a heated core and on primary decompression phenomena. The test results presented include pressure, fluid and material temperatures, fluid density, flow rates, and fluid quality as functions of time. (9 references) (auth)

24794 COOLING OF EXPERIMENTAL SUBASSEMBLIES DURING REMOVAL FROM THE EBR-II REACTOR. Cushman, R. A.; Perry, W. H.; Sackett, J. E. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). pp 27-35 of Spent Nuclear Fuel Heat Transfer: Fuel Casks and Transfer Operations. /Groetch, D. J. (ed.). New York; American Society of Mechanical Engineers (1971).

From Symposium on spent nuclear fuel heat transfer: fuel casks and transfer operations; Washington, D. C. (1 Dec 1971).

The EBR-II fuel handling, unloading, and interbuilding transfer system was designed to transfer driver fuel subassemblies from the Fuels and Examination Facility to the reactor core, and then, following irradiation, from the reactor core back to the Fuels and Examination Facility. The system was designed to cool a driver subassembly which was producing 1.2 kW of decay heat. EBR-II is serving as the principal fast flux irradiation facility in the LMFBR program, and much of the core is filled with experimental fueled and structural subassemblies. These experimental subassemblies are orificed to reduce their coolant flow rate, and may contain from 7 to 61 fuel elements rather than the 91 elements that a standard driver contains. An experimental and analytical investigation was performed to determine the capability of the fuel transfer system to cool these subassemblies, and to determine what level of decay heat is permissible for the various subassemblies. It was determined that the highest temperatures occur while the subassemblies are in the primary tank and are being cooled by forced argon. Adequate cooling can be provided, but at subassembly decay powers less than 1.2 kW. (auth)

Operation and Economics

Refer also to abstract 24936.

24795 (AECL-3970) FORESEEN DEVELOPMENT OF CANDU REACTORS TO 2000 A. D. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan 1972. 10p. (DL-107; CONF-710642-1). Dep. NTIS (U. S. Sales Only). AECL $0.50.

From eleventh annual international conference of the Canadian Nuclear Association; Montreal, Canada (20 Jun 1971).

The CANDU power reactor is characterized by the lowest fuel cycle costs achieved by high power fueled channels forming a lattice in heavy water moderator. Various fuel cycles and coolant systems are possible. When thorium fuel is used the individual fuel bundles will deliver energy in the range 20 to 60 MWd/kg thorium. Consequent fuel changes are not too frequent and high availability is foreseen. The fuel inventory is quite low but some fissile fuel make up is required in the cycle. High temperature organic liquid coolant is promising. Such reactors are expected to remain economically competitive for a long-term future, possibly for many centuries. (23 references) (auth)

24796 (ORNL-4658) CHEMICAL ASPECTS OF MSRE OPERATIONS. Thoma, Roy E. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 145p. Dep. NTIS.

Results of laboratory analyses performed in surveillance of MSRE salt, water, cover gas, and oil systems are tabulated. Excepted are analytical data pertaining to fission product and tritium distribution and transport. Conclusions are presented from chemical analyses performed from the 1964 preoperational test period until termination of power operations in 1969, modified by the results of postoperational examination of the reactor components. Surveillance results were evaluated with respect to their significance as indicators of the performance of the MSRE and as indicators of the need and potential for development of specific in-line methods of analysis for molten-salt power reactors. As judged from chemical data, the MSRE was highly successful as a materials demonstration. The flowing salts did not wet their containment systems; fuel salt neither wetted nor penetrated the graphite moderator surface. The cumulative generalized corrosion within the fuel circuit resulted in the removal of chromium from the alloy to an average depth of 0.4 mil, while that in the coolant system was undetectably low. The results of postoperational examinations, although corroborative of predicted corrosion, also indicated finite but slight intergranular attack. In operations which successively employed ^{235}U, ^{233}U, and ^{239}Pu as sources of power in the reactor, the circulated fluids remained chemically stable, free of radiation damage, and free of contamination. The average full-power output of the reactor, as computed from experimental results of isotopic dilution mass spectrometric analysis of fissile species and subsequently confirmed by capture-to-absorption ratio measurements, was shown to be 7.4 MW(t). (auth)

24797 PUBLIC INVESTMENT PLANNING IN CIVILIAN NUCLEAR POWER. Vernon, John M. Durham, N. C.; Duke University Press (1971). 177p.

The development of advanced converter reactors in order to conserve uranium is examined from a cost-benefit standpoint. The cost of producing electricity in light water nuclear plants is discussed and cost savings expected from advanced converters are studied. The economics of the uranium industry are predicted for a nuclear power growth pattern with and without advanced converters. Benefits of the advanced converter development are calculated using a decision-tree approach. Results of the cost-benefit analysis are summarized. (H.D.R.)

24798 MAN-REM, ECONOMICS, AND RISK IN THE NUCLEAR POWER INDUSTRY. Wilson, R. (Ontario Hydro, Toronto). Nucl. News; 15: No. 2, 28-30(Feb 1972).

The importance of man-rem consumption as a parameter in power station construction and operation is discussed. Worker safety and economics aspects are considered. (10 references) (H.D.R.)

24799 EVOLUTION OF NUCLEAR PLANT COSTS. McTague, Peter J.; Davidson, G. J.; Bredin, R. M.; Herman, A. A. (Gilbert Associates, Inc., Reading, Pa.). Nucl. News; 15: No. 2, 31-5(Feb 1972).

Nuclear plant cost estimates for plants to be completed in the early 1970s are analyzed. Original cost estimates are shown to be about $150 per kilowatt lower than actual costs. Specific typical projects are analyzed to identify the dollar contribution of causes of the cost increases. (H.D.R.)

24800 CAN NUCLEAR ENERGY COMPETE WITH NATURAL GAS. Hondius, H. (N. V. Nederlandse Gasunie, Groningen, Netherlands). Ingenieur (Utrecht); 83: A357-65(28 May 1971). (In Dutch).

An impression of the role Groningen gas plays and eventually will play in the field of public electric-power generation in the Netherlands in the period 1966 to 1975 is presented. The consideration which prompted the N. V. Nederlandse Gasunie to engage Ebasco Services Inc. of New York to project a power plant with two units with an output of 600 MW and 800 MW at a new salt-water site is discussed. Founded on detailed descriptions, investment calculations were made which formed the base for economic evaluations from which for various capacity factors the break-even costs for natural gas at which it would be competitive with nuclear power were calculated. The results of these evaluations projected against the contractual Dutch gas prices are given and conclusions for the immediate future are drawn. (auth) (Netherlands)

24801 STATUS OF PLUTONIUM RECYCLE DEVELOPMENTS. Astley, Wayne C. (Philadelphia Electric Co.); Walke, Gerald J.; Ladesich, John. Proc. Amer. Power Conf.; 33: 226-32(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The status of the Edison Electric Institute program for evaluating the economics and technical parameters of recycling plutonium in light-water reactors is described. (H.D.R.)

24802 END OF AEC BUYBACK; BEGINNING OF COMMERCIAL PLUTONIUM RECYCLE. Haley, James (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 33: 239-46(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The economic necessity for plutonium recycle in light-water reactors is discussed, and the need for an integrated industry development program in plutonium recycle technology is described. (H.D.R.)

24803 INTERACTIONS BETWEEN NUCLEAR PLANT LOADING CHANGES AND NUCLEAR FUEL COSTS. Bonk, G. J. (General Electric Co., Schenectady, N. Y.); Crowther, R. L.; Thompson, O. A. Proc. Amer. Power Conf.; 33: 253-63(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24804 NEW TRAINING CENTER FOR NUCLEAR POWER PLANT OPERATION AT ZION. Kelly, Frank L. (Westinghouse Electric Corp., Monroeville, Pa.); Guppy, William H. Proc. Amer. Power Conf.; 33: 294-301(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The facilities of the Westinghouse Nuclear Training Center near the Zion Nuclear Station are described. The center provides the requisite pressurized water reactor familiarization for a comprehensive training program for station operators. (H.D.R.)

24805 COLUMBIA RIVER HYDRO SYSTEM CONSTRAINTS ON THE NUCLEAR FUEL CYCLE. Starr, E. C.; Tallman, R. J.; Fuller, N. E.; Huffman, W. B. (Bonneville Power Administration, Portland, Oreg.). Proc. Amer. Power Conf.; 33: 935-9(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Problems of coordinating large nuclear power plants with the Pacific Northwest Hydro System are discussed. The effects of a large hydro system on nuclear fuel management are examined. (H.D.R.)

24806 TVA COMMUNICATION SYSTEM REQUIREMENTS FOR LARGE NUCLEAR AND FOSSIL-FUELED POWER PLANTS. Luallen, L. H.; Foster, W. M. (Tennessee Valley Authority, Knoxville). Proc. Amer. Power Conf.; 33: 1094-1100(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Voice and audio signals and other means of communications between operating personnel as required for startup, operation, and shutdown of large nuclear and fossil-fueled power plants are described. (H.D.R.)

Safety and Siting

Refer also to abstract 24938.

24807 (ANL-7890) INTERACTION OF SODIUM WITH MOLTEN UO_2 AND STAINLESS STEEL USING A DROPPING MODE OF CONTACT. Armstrong, D. R.; Testa, F. J.; Raridon, D. Jr. (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 23p. Dep. NTIS.

A series of 12 experiments were performed to examine the pressures and forces generated by dropping molten reactor materials (UO_2 and stainless steel) into sodium. In these experiments, a crucible containing about 25 g of UO_2 or stainless steel was heated inductively; the crucible was then inverted and the molten contents poured into a sodium container. Continuous measurements of the pressure in the sodium container, the force exerted on the sodium container, and the overpressure in the gas space above the sodium were made. The entire event was photographed with high-speed motion picture film at 1000 frames/sec. After the event, data were obtained on the distribution of UO_2 particle size and the spatial distribution of sodium around the container. None

of the 12 experiments produced a pressurization rapid enough to be termed an explosion; thus, the results are of little direct value in describing a fuel-sodium vapor explosion. 7 references. (auth)

24808 (CENPD-16(Rev.1)) COMBUSTION ENGINEERING ANALYTICAL TECHNIQUES FOR EVALUATING LOSS-OF-COOLANT ACCIDENTS. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). 14 Feb 1972. 138p.

Includes Amendment 1.

Current analytical techniques for coolant loss accidents are reviewed. The methods of analyses are described and several sample cases are provided. (auth)

24809 (IRS-I-47(1971)) MAN AS SUBJECT OF CONSISTENT SAFETY APPRAISAL IN THE FRAMEWORK OF LEGAL ATOMIC AUTHORIZATION PROCEDURE. Study for a Research Program. Dick, Christian (Technischer Ueberwachungs-Verein e.V., Cologne (West Germany). Institut fuer Reaktorsicherheit). [1971]. 60p. (In German). Dep. NTIS (U. S. Sales Only).

Realization of a nuclear power plant project is conceived as the stepwise transformation of abstract reactor models. The goal of a safety evaluation is the examination of validity and reliability for each model transformation. Information necessary for such an examination shows gaps. To bridge these gaps, a research program with eight main themes is outlined and arranged according to priority. The themes are: optimal distribution of functions between man and machine; specification and analysis of human functions; design of technical components for easy handling; assessment of human capabilities; optimal monitoring system for construction and operation; design of symbolized rules; personnel training; and optimal organization of personnel. Research requirements are assessed with respect to personnel and cost. (H.B.G.)

24810 (TRG-Report-2224) WINDSCALE HIGH INTENSITY NOISE RIG. Parkin, M. W. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group). 1972. 11p. Dep. NTIS (U. S. Sales Only). UK 0,50 pound.

As the power of machines increases so the associated sound pressure levels increase. These high sound pressures (150–170 db) can cause serious structural damage by inducing fatigue or fretting mechanisms. A rig is described which was designed to reproduce high noise levels for the examination of these problems in nuclear power applications. It is also suitable for general applications. (auth)

24811 NUCLEAR POWER PLANT TORNADO DESIGN CONSIDERATIONS. Dunlap, James A.; Wiedner, Karl (Bechtel Corp., San Francisco). J. Power Div., Amer. Soc. Civil Eng.; PO2: 407-17(Mar 1971).

The literature concerning studies of the probability of tornado occurrence and of the great forces a tornado can impart to structures is briefly reviewed. Tornadoes can be characterized as vortices possessing tangential, radial and translational velocities, whose net effect is a strong wind force varying from a small value at the center to a maximum at the wall of the funnel cloud, and then decreasing with the increase in distance from the center. Three potential sources of damage are from the dynamic wind loading, the pressure difference between the inside and outside of a building, and the possible impact of wind driven missiles. The maximum wind design velocity at the top of a nuclear reactor building is 265 mph for a tornado with a maximum wind velocity of 300 mph. The maximum pressure differential chosen for design is 3 psi based on the cyclostrophic wind equation and the tangential velocity distribution for a 60 mph translation velocity. This maximum value is much larger than any officially recorded values. Procedures for calculating impact damage by wind-driven missiles need experimental work to confirm and supplement procedures which have been developed in the course of ordnance studies. (12 references) (auth)

24812 ENVIRONMENTAL ASPECTS OF HIGH-TEMPERATURE GAS-COOLED REACTORS. Goodjohn, A. J.; Fortescue, P. (Gulf General Atomic Co., San Diego, Calif.). Proc. Amer. Power Conf.; 33: 136-44(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Techniques for the reduction of radioactive effluents from HTGR type reactors are described, and the potential of closed-cycle gas turbines with air cooling to reduce the effects of waste heat discharge is discussed. (H.D.R.)

24813 CAPACITY OF COOLING PONDS TO DISSIPATE HEAT. Patterson, W. D.; Leporati, J. L.; Scarpa, M. J. (Ebasco Services Inc., New York). Proc. Amer. Power Conf.; 33: 446-56(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

A method of analyzing the heat dissipation characteristics of cooling ponds is presented. A procedure is suggested for evaluating the effectiveness of closed-cycle cooling ponds loaded more heavily than 1¼ to 1½ acres per megawatt of station power. (H.D.R.)

24814 MODELING OF THERMAL DISCHARGES IN SHALLOW ESTUARIES. Espey, W. H. Jr. (TRACOR, Inc., Austin, Tex.); Betterton, D. R.; Mary, A. J.; Mayer, William M. Proc. Amer. Power Conf.; 33: 457-64(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Water quality aspects of a mathematical temperature model which describes the change in the thermal characteristics of a shallow estuary resulting from thermal discharges are summarized. (H.D.R.)

24815 TVA'S POWER PLANT DESIGN: A DEMONSTRATION IN TOTAL ENVIRONMENTAL PLANNING. Adkins, W. C.; Gibney, L. V. (Tennessee Valley Authority, Knoxville). Proc. Amer. Power Conf.; 33: 611-20(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The architectural and aesthetic approach employed by the Tennessee Valley Authority to achieve environmental quality in planning new power projects is discussed. A nuclear plant, a fossil-fueled plant, and a pumped storage hydro plant are cited as examples of the total environmental design concept. (H.D.R.)

24816 STUDY ON EXISTING SYSTEM OF INDEMNIFICATION FOR NUCLEAR POWER ACCIDENTS BY AN AD HOC COMMITTEE. Genshiryoku Iinkai Geppo; 15: No. 12, 36-40 (Dec 1970). (In Japanese).

A report by an ad hoc committee to the AEC Chairman is presented on a study of the existing system of nuclear accident indemnification. Contents of the report are on the following: limitation in the indemnification by private enterprise and state aid in cases of land facilities and nuclear-powered ships; maximum indemnification allotment to private enterprise; indemnification for employees; and others (security firm, damage to third parties, liability during fuel transport, liability to outsiders, handling of fuels, wastes, etc., and damages by nuclear-powered ships, etc.). (Japan)

24817 SAFETY APPARATUS FOR NUCLEAR REACTORS. Zivi, Samuel M. (to TRW Inc.). U. S. Patent 3,629,064. 21 Dec 1971. Filed 9 Sep 1968.

The method of the invention consists of placing a layer of dense, high-melting temperature material such as unenriched uranium dioxide (UO_2), under a nuclear reactor to support by flotation large masses of molten reactor fuel which might otherwise melt through the floor and the containment shell. The apparatus of the invention is comprised of a dish-shaped layer of unenriched UO_2, or similar material which is encased in a steel housing. The diameter of the dish-shaped layer is greater than the diameter of the reactor core and if located external to the reactor pressure vessel, the diameter of the layer is at least as great as that of the vessel. (Official Gazette)

24818 CHARACTERISTICS OF VALVES FOR NUCLEAR POWER PLANTS. Ishiyama, T. (Nippon Sealol Co. Ltd., Tokyo). Genshiryoku Kogyo; 17: No. 4, 46-50(Apr 1971). (In Japanese).

Valves installed in Japanese nuclear power plants already in operation were imported from the U.S.A., and those valves important for safety control will continue to be imported. Construction, characteristics, operation and maintenance of these safety-related valves are described. (Japan)

24819 SAFETY ARRANGEMENT FOR NUCLEAR POWER STATION. Profos, O. (to Sulzer Brothers Ltd.). Canadian Patent 884,595. 26 Oct 1971. Priority date 19 Sep 1967, Switzerland.

The nuclear power station is constructed to house the reactor pressure vessel above the machine room ceiling. The thickness of this ceiling can be relatively small. Should a leak of working medium occur in the machine room, the pressure on the ceiling is counterbalanced by the weight of the reactor. (F.S.A.) (Canada)

24820 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Sheldon, Myrtleen. Nucl. Safety; 13: No. 2, 141-55(Mar-Apr 1972).

Steam and Power Conversion System

24821 (JPRS-55302) DISTINCTIVE FEATURES IN THE ANALYSIS OF CYCLES OF GAS-TURBINE ATOMIC POWER PLANTS. Smirnov, G. F.; Klok, A. M.; Kalishevich, Yu. I.; Lomonosov, M. V. Translated from Izv. Vyssh. Ucheb. Zaved., Energ.; No. 12, 51-6(Dec 1971). 8p. NTIS.

Thermodynamic analysis of the cycles of single-circuit gas-turbine nuclear power plants is presented. 7 references. (auth)

24822 HEAT EXCHANGER USING THERMAL CONVECTION TUBES. France, David M.; Petrick, Michael (to United States

Atomic Energy Commission). U. S. Patent 3,633,665. 11 Jan 1972. Filed 11 May 1970.

A heat exchanger is constructed with the hotter fluid in a lower region and the cooler fluid in an upper region. A single wall separates the two regions. Vertically mounted thermal convection tubes extending from the hotter fluid to the cooler fluid through the wall act to transfer heat between the fluids. The thermal convection tubes contain a working fluid and provide for substantially isothermal heat transfer, the latent heat of vaporization of the working fluid being the primary mechanism responsible for this heat transfer. (auth)

24823 EFFECTS OF HIGH CONDENSER PRESSURE ON STEAM TURBINE DESIGN. Silvestri, G. J. Jr.; Davids, J. (Westinghouse Electric Corp., Lester, Pa.). Proc. Amer. Power Conf.; 33: 319-28(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24824 ULTRASONIC CLEANING OF DEEP-BED RESINS FOR CONDENSATE DEMINERALIZER SYSTEMS. Holloway, J. H.; Hollifield, P. J. (General Electric Co., Pleasanton, Calif.). Proc. Amer. Power Conf.; 33: 815-22(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The development of a method for removing crud and other types of resin fouling solids from deep-bed resins is described. The method utilizes a cleaning column designed to apply ultrasonic energy to a water/resin slurry. The performance of a prototype one cubic foot per minute model installed in the condensate demineralizer regeneration room at the Dresden power reactor, Unit 1, is summarized. (H.D.R.)

Commercial Power Reactors

Refer also to abstracts 22759, 22761, and 23295.

24825 (FIND-50305(3-72)) FIND: KEWAUNEE NUCLEAR POWER PLANT. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 15 Mar 1972. Contract AT(40-1)-4247. 24p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

24826 (JPRS-55301) ROLE OF ATOMIC POWER ENGINEERING IN DEVELOPMENT OF USSR POWER ENGINEERING. Margulova, T. Kh. Translated from Izv. Vyssh. Ucheb. Zaved., Energ.; No. 12, 48-50(Dec 1971). 5p. NTIS.

24827 TRANSPORTATION AND ERECTION OF LARGE NUCLEAR STEAM SYSTEM COMPONENTS. Eynon, W. J. (Babcock and Wilcox Co., Barberton, Ohio). Proc. Amer. Power Conf.; 33: 264-74(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The planning and preparations necessary to transport and erect the steam generators and pressure vessel of the Oconee Nuclear Station, Unit 1, are described. (H.D.R.)

24828 NUCLEAR POWER IN CZECHOSLOVAKIA. Neumann, Jan; Barabas, Karel (Czech Atomic Energy Commission, Prague). Jad. Energ.; 17: No. 12, 397-400(Dec 1971). (In Czech).

Developments in the field of nuclear power in Czechoslovakia are discussed. Power requirements in general are discussed. It is concluded that widespread construction of atomic electric power stations is essential. A program of such projected construction to 1990 is presented. (tr-auth)

24829 SIMULATING STRONG-MOTION EARTHQUAKE EFFECTS ON NUCLEAR POWER PLANTS. Smith, C. B.; Matthiesen, R. B. (Univ. of California, Los Angeles). Nucl. Safety; 13: No. 2, 113-21(Mar-Apr 1972).

Research being conducted to determine the effects of earthquakes on nuclear power plants includes dynamic tests on full-scale nuclear power plants and the development of mathematical models of the system based on experimental results. These tests have been conducted at the UCLA research reactor, the Experimental Gas-Cooled Reactor (EGCR), the Carolinas-Virginia Tube Reactor (CVTR), the Fermi Fast Breeder Reactor, and the San Onofre Nuclear Generating Station. Experimental investigations include the response due to ambient excitation (wind and natural ground vibrations), forced vibrations using structural vibrators, forced vibrations using impulses, free vibrations from a large initial displacement ("snapback" tests), and forced vibrations caused by explosive blasts. The major emphasis of the work is on developing methods for exciting full-scale structures at levels comparable with strong-motion earthquakes and using these tests to develop mathematical models for reactor systems. Current effort is concentrated on analyzing the results of blast tests. Analysis to date has proved the feasibility of the blast techniques and is giving insight into the nonlinearities associated with high-level response. Excellent agreement was obtained in comparisons of forced-vibration test data and blast data. Nevertheless, nonlinear behavior of nuclear plant components is still not well understood, and additional work is required to define the mechanisms that give rise to nonlinearities. (auth)

Control and Instrumentation

24830 TESTING OF LARGE CURVED PRESTRESSING TENDONS. Harstead, Gunnar A.; Kummerle, E. Richard; Archer, John C.; Porat, Mark M. (Burns and Roe, Inc., Oradell, N. J.). J. Power Div., Amer. Soc. Civil Eng.; PO2: 475-92 (Mar 1971).

A test program was conducted to investigate the suitability and corrosion protection of grouted strand tendons selected to be used in the containment building for Unit 2 of the Three Mile Island Nuclear Station. The tests conducted on a mockup of a segment of the cylindrical concrete wall demonstrated that effective grout coverage of the tendons will be achieved using the proposed grouting procedures. This will provide corrosion protection and effective bonding of the tendons to the concrete structure. (H.D.R.)

24831 PRESTRESSING SYSTEM FOR H. B. ROBINSON NUCLEAR PLANT. Wern, Allan H. (Ebasco Services Inc., New York); Schupack, Morris; Larson, Walter. J. Power Div., Amer. Soc. Civil Eng.; PO2: 539-66(Mar 1971).

The H. B. Robinson containment structure is a hybrid design reinforced/prestressed concrete structure consisting of a right cylinder and a hemispherical dome roof. The vertical prestressing steel elements in the structure are described and their purpose, design details, testing, fabrication, erection, stressing, and grouting are examined. (H.D.R.)

24832 DECONTAMINATION OF A PWR PRIMARY SYSTEM, SENA PLANT. Couez, H. (Ateliers De Constructions Electriques, de Charleroi, Belgium); Picone, L. F. Proc. Amer. Power Conf.; 33: 757-75(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The decontamination operation for a detailed inspection and repair of the SENA reactor steam generator tubesheet faces is described. Chemical and radiochemical aspects of the operation are detailed. (H.D.R.)

24833 PREVENTION AND CONTROL OF CORROSION PRODUCT DEPOSITION IN A BWR (GARIGLIANO POWER STATION). Gasparini, Romano; Joannilli, Edmondo (ENEL, Rome). Proc. Amer. Power Conf.; 33: 776-89(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

During the first and second fuel cycles of the Garigliano reactor, large amounts of crud were deposited at the fuel assembly inlets. The results of a study of the crud deposition mechanisms and of the control and prevention of corrosion product deposits in general are presented. Preliminary tests that appear to be of interest for in-service cleaning are described. (H.D.R.)

24834 APPLICATIONS OF OPERATOR AID COMPUTERS IN NUCLEAR POWER PLANTS. Reeves, Henry L. Jr. (Duke Power Co., Charlotte, N. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-90: No. 6, 2528-33(Nov-Dec 1971).

Duke Power Company installs a plant computer for each new generating unit which is called an Operator Aid Computer. Application at Oconee Nuclear Station, which is Duke's first commercial nuclear station, required new functions. The differences in the application at Oconee and future nuclear stations are compared to the functions required at previous fossil-fired stations. (auth)

24835 CHARCOAL BED SYSTEM FOR TSURUGA PLANT. At. Jap.; 15: No. 7, 15-18(Jul 1971).

In design and operation of the Tsuruga nuclear power plant of Japan Atomic Power Co., comprising a BWR of 357 MW(e) and operating since March 1970, careful consideration was given to reduction of radioactivity in effluent from the plant. The Tsuruga plant is equipped with two off-gas decay tanks of 15m^3, each capable of holding the off-gas from a turbine air ejector for 24 hours. Thirty min holdup lines as standard for BWRs are not enough for the principle of keeping such radioactivity as low as practicable. A study was undertaken on operational performance of charcoal bed systems used in Germany. Experiments with a small model of the charcoal bed system in Japan confirmed bright prospects for its practical use. In the Tsuruga power station, the off-gas from the turbine air ejector is led into the decay tanks. The charcoal bed

system is installed after the decay tanks, and radioactive noble gases such as Xe and Kr are reduced further by being held for a long time. The off-gas is then passed through an absolute filter and released into the atmosphere. Design conditions for the charcoal bed system are as follows: off-gas flow rate 20 Nm^3/hr, holding time 20 days for Xe, system pressure negative, and temperature 30°C. The system comprises 8 charcoal beds charged with 26 tons of charcoal. (Japan)

24836 CHARCOAL BED SYSTEM FOR TSURUGA NUCLEAR POWER PLANT. Tanimura, K. (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo; 17: No. 10, 31-4(Oct 1971). (In Japanese).

Rare gas hold up equipment to be installed at Tsuruga power station is described. The equipment is a type based on use of charcoal beds. Principles and constitution of the rare gas hold up equipment are explained. Design conditions are: (1) design mass flow: 20 Nm^3/hr, (2) hold up time of Xe: 20 days, (3) system pressure: subatmospheric, (4) charcoal: Takedashirasagi G mesh No. 4-6. The equipment consists of two pre-dehumidifiers, two sand filters, two after dehumidifiers, eight adsorption towers, two exhaust gas filters and two exhaust gas extractors. Exhaust gas is cooled down to −5°C at the predehumidifiers, and about −25°C at the after dehumidifiers. Considerations given to design of the equipment are: provision of stand-by components; provision of heaters for antifreezing; provision of space for 2 more adsorption towers; adoption of air ejectors to eliminate gas leakage; adoption of bellow sealed valves to minimize leakage; provision of 1 m thick concrete shielding to facilitate maintenance work; and centralization of valves to be maintained or operated frequently during operation. (Japan)

24837 DOMESTIC PRODUCTION OF NUCLEAR FUEL IN RUNNING EXPERIMENT JUDGEMENT. PWR. Nagino, Y. (Kansai Electric Power Co. Inc., Osaka). Genshiryoku Kogyo; 17: No. 9, 12-15(Sep 1971). (In Japanese).

In the Mihama nuclear power station a PWR is used for the first time in Japan. Effective use of the fuel and smooth operation of the reactor are essential. Domestic production of nuclear fuel must be carried out. In this connection, after reviewing features of PWR cores, the following are explained. (1) Combined technology of the reactor core and the fuel. To have high operation efficiency of the PWR plant under peculiar conditions, design of the fuel must be matched to that of the reactor core. (2) Supply of reliable fuel. Though operational need such as in (1) is satisfied, integrity of the fuel itself must be ensured, including avoidance of rupture of the fuel to make for the smooth operation and maintenance of the reactor plant. (Japan)

Operation and Economics

24838 (DOCKET-50010-105) DRESDEN NUCLEAR POWER STATION, UNIT 1. Request for Permission for Storage of Turning Vane on Site. (Commonwealth Edison Co., Chicago, Ill.). 14 Mar 1972. 9p. Dep. NTIS.

24839 (DOCKET-50016-152) ENRICO FERMI ATOMIC POWER PLANT. Report for November 1971. (Power Reactor Development Co., Detroit, Mich.). 15 Mar 1972. 14p. (PRDC-EF-99). Dep. NTIS.

24840 (DOCKET-50016-153) ENRICO FERMI ATOMIC POWER PLANT. Leak in Primary Sodium System. (Power Reactor Development Co., Detroit, Mich.). 22 Mar 1972. 5p. Dep. NTIS.

24841 (DOCKET-50029-172) YANKEE NUCLEAR POWER STATION. Operations Report No. 134, Month of February 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Mar 1972. 10p. Dep. NTIS.

24842 (DOCKET-50155-106) BIG ROCK POINT NUCLEAR PLANT. Plan to Reinsert Five Reconstituted Fuel Bundles. (Consumers Power Co., Jackson, Mich.). 27 Mar 1972. 5p. Dep. NTIS.

24843 (DOCKET-50171-100) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Semiannual Operations Report No. 65, July 1, 1971-December 31, 1971. (Philadelphia Electric Co., Pa.). 1972. 35p. Dep. NTIS.

24844 (DOCKET-50206-152) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Inoperability of Main Steam Safety Valves RV-3 and RV-5. (Southern California Edison Co., Rosemead, Calif.). 25 Feb 1972. 3p. Dep. NTIS.

24845 (DOCKET-50213-136) HADDAM NECK PLANT. Operation Report 72-2, February 1972. (Connecticut Yankee Atomic Power Co., Haddam). 23 Mar 1972. 15p. (NYO-3144-69). Dep. NTIS.

24846 (DOCKET-50237-223) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Steps Taken to Correct Items of Apparent Noncompliance Described in Letter of January 20, 1972. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 7 Mar 1972. 9p. (DOCKET-50249-124). Dep. NTIS.

Additional information is presented concerning operating procedures for the feedwater valve lockout and tripping of the feedwater pump, failure to initiate torus spray at drywell pressure surge, and control rod drive testing intervals. (D.C.C.)

24847 (DOCKET-50237-225) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Secondary Containment Leak Rate Test Summary. (Commonwealth Edison Co., Chicago, Ill.). 17 Mar 1972. 4p. (DOCKET-50249-127). Dep. NTIS.

24848 (DOCKET-50244-95) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Failure of Main Steam Isolation Valve MSIV-1B to Close. (Rochester Gas and Electric Corp., N. Y.). 30 Mar 1972. 2p. Dep. NTIS.

24849 (DOCKET-50245-120) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Position Switch on Isolation Valve Out of Adjustment. (Millstone Point Co., Hartford, Conn.). 13 Mar 1972. 1p. Dep. NTIS.

24850 (DOCKET-50245-122) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence AO-72-11, Gas Turbine Failed to Start After a Main Turbine Trip. (Millstone Point Co., Hartford, Conn.). 20 Mar 1972. 2p. Dep. NTIS.

24851 (DOCKET-50247-66) INDIAN POINT NUCLEAR GENERATING UNIT 2. Coolant Pressure Buildup Due to Thermal Expansion. (Consolidated Edison Co. of New York, Inc., New York). 17 Mar 1972. 3p. Dep. NTIS.

24852 (DOCKET-50247-67) INDIAN POINT NUCLEAR GENERATING UNIT 2. Order Extending Expiration Date to July 19, 1972. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1972. 6p. Dep. NTIS.

Extension of the operating license expiration date for the Indian Point Power Reactor Unit 2 is presented. (D.C.C.)

24853 (DOCKET-50249-126) DRESDEN NUCLEAR POWER STATION, UNIT 3. Wiring Error Detected in Circuitry. (Commonwealth Edison Co., Chicago, Ill.). 17 Mar 1972. 3p. Dep. NTIS.

Incorrect wiring in the logic circuitry of the containment spray system is described. Corrective actions are presented. (D.C.C.)

24854 (DOCKET-50254-71) QUAD-CITIES STATION, UNIT 1. Facility Operating License DPR-29, Amendment 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Mar 1972. 7p. Dep. NTIS.

Revised possession limits for antimony-124 sources are presented. (D.C.C.)

24855 (DOCKET-50255-78) PALISADES PLANT. Defective Emergency Diesel Discovered on Monthly Surveillance Test. (Consumers Power Co., Jackson, Mich.). 10 Mar 1972. 2p. Dep. NTIS.

24856 (DOCKET-50255-79) PALISADES PLANT. Leaks in Welds. (Consumers Power Co., Jackson, Mich.). 6 Mar 1972. 2p. Dep. NTIS.

Repair procedures are described for a leak in welds of the P-55A charging pump discharge shutoff valve and check valve for the primary cooling system. (D.C.C.)

24857 (DOCKET-50255-80) PALISADES PLANT. Four Abnormal Occurrences. (Consumers Power Co., Jackson, Mich.). 22 Mar 1972. 4p. Dep. NTIS.

Abnormal occurrences are described which concern the tripping of generator output breakers and malfunction of control rod drive motors. Corrective actions are discussed. (D.C.C.)

24858 (DOCKET-50259-42) BROWNS FERRY NUCLEAR POWER STATION, UNIT 1. Steps Taken to Correct Items of Apparent Noncompliance of Letter of February 16, 1972. (Division of Compliance (AEC), Atlanta, Ga. Region II). 28 Mar 1972. 6p. Dep. NTIS.

Hydrostatic testing procedures for piping systems are reviewed. Required revisions are presented. (D.C.C.)

24859 (DOCKET-50263-116) MONTICELLO NUCLEAR GENERATING PLANT. Malfunction of RCIC High Steam Flow Isolation Switch. (Northern States Power Co., Minneapolis, Minn.). 15 Mar 1972. 1p. Dep. NTIS.

24860 (DOCKET-50271-75) VERMONT YANKEE NUCLEAR POWER STATION. Documentation Supporting Technical Specification for Operation at 1 percent of Rated Power. (Vermont

Yankee Nuclear Power Corp., Rutland). 10 Mar 1972. 2p. Dep. NTIS.

24861 (DOCKET-50321-33) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Program for Removal of Ultrasonic Reflectors from Reactor Pressure Vessel. (Georgia Power Co., Atlanta). 7 Mar 1972. 3p. Dep. NTIS.

24862 (DOCKET-50334-30) BEAVER VALLEY POWER STATION, UNIT 1. Fire Adjacent to Outside of Containment Structure on January 3, 1972. (Division of Compliance (AEC), Newark, N. J. Region I). 23 Feb 1972. 8p. Dep. NTIS.

24863 (NP-19198) ANNUAL REPORT, 1970. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 15p. Dep. NTIS (U. S. Sales Only).

The annual report for 1970 by the board and the managing director of AB Atomenergi is presented. Market development in nuclear energy during 1970 is discussed. Research and development work on light-water-cooled reactors and their fuels was the main task of the company. At the end of the year the number of employees was 1100. (Sweden)

24864 STARTUP AND POWER ESCALATION OF THE H. B. ROBINSON UNIT NO. 2 NUCLEAR POWER PLANT. Leblang, Joseph; Thompson, Francis L. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf.; 33: 175-80(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24865 UNITED STATES EXPERIENCE WITH FAST POWER REACTORS: FERMI 1. Branyan, Charles E.; Olson, William R. (Power Reactor Development Co., Newport, Mich.). Proc. Amer. Power Conf.; 33: 191-201(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The Fermi Fast Breeder Reactor operating history and statistics are reviewed, plant improvements and component experience are described, and the objectives of the UO_2 fueled core program are presented. (8 references) (H.D.R.)

24866 OPERATING EXPERIENCE, REFUELING, AND RESULTS OF IN-SERVICE INSPECTION OF THE 320-MWe PWR OBRIGHEIM NUCLEAR POWER PLANT. Braun, W.; Orth, K. (Siemens AG, Erlangen, Ger.). Proc. Amer. Power Conf.; 33: 202-6(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

24867 LARGE BOILING-WATER REACTORS: OPERATIONS CONFIRM DESIGN. Levy, S.; Bray, A. P.; Cage, J. F.; Kjemtrup, J. E. (General Electric Co., San Jose, Calif.). Proc. Amer. Power Conf.; 33: 207-25(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

Some of the principal data accumulated during the startup and power test programs of 11 large boiling water reactors are presented and compared with the original design bases. (H.D.R.)

24868 UTILITY OPERATED CORE ANALYSIS AND CORE MANAGEMENT SYSTEM. Fisher, J. R. (Nuclear Associates International Corp., Rockville, Md.); Rubino, L. F. Proc. Amer. Power Conf.; 33: 233-8(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The system used for long-term predictive core analysis and management at the Peach Bottom boiling water reactors (Units 2 and 3) is described. (H.D.R.)

Safety and Siting

Refer also to abstract 24824.

24869 (ANL/ES-3) THERMAL PLUMES IN LAKES: COMPILATIONS OF FIELD EXPERIENCE. Tokar, J. V. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 169p. Dep. NTIS.

The state-of-the-art on the available methods for predicting the extent and temperature structure of thermal plumes existing at power-plant outfalls is surveyed. Emphasis is placed on plumes within large stratified lakes. Two companion reports include a review of analytical, numerical, and hydraulic modeling of thermal plumes and concentrate on predictive techniques. Field data and experience that could possibly be used to validate the predictive methods are presented. An inventory of the existing or proposed power plants sited along the shores of the Great Lakes is included. 24 references. (auth)

24870 (DOCKET-50016-154) ENRICO FERMI ATOMIC POWER PLANT. Technical Specifications, Request for Authorization of Change 29, Revision 1. (Power Reactor Development Co., Detroit, Mich.). 27 Mar 1972. 23p. Dep. NTIS.

Revised technical specifications are presented concerning peak burnup limits for fuel element assemblies, and the connection of the delayed neutron detector circuit to the reactor scram system. (D.C.C.)

24871 (DOCKET-50029-171) YANKEE NUCLEAR POWER STATION. Proposed Change 96, Supplement 3. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Mar 1972. 16p. Dep. NTIS.

Requested additional information is presented concerning performance of the emergency core cooling systems, modifications to the instrumentation and electrical systems, and revised minimum shutdown margin for a control rod stuck in fully withdrawn position. (D.C.C.)

24872 (DOCKET-50133-80) HUMBOLDT BAY POWER PLANT, UNIT 3. Meteorological Data, January 1, 1966-December 31, 1967. (Pacific Gas and Electric Co., San Francisco, Calif.). 29 Mar 1972. 15p. Dep. NTIS.

24873 (DOCKET-50220-86) NINE MILE POINT NUCLEAR STATION. Proposed Program of Continuing Surveillance of Sensitized Material. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 24 Mar 1972. 3p. Dep. NTIS.

Inspection requirements are presented for sensitized stainless steel used in the pressure vessel and primary cooling system. (D.C.C.)

24874 (DOCKET-50244-93) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Information on Main Steam Header. (Rochester Gas and Electric Corp., N. Y.). 24 Mar 1972. 4p. Dep. NTIS.

24875 (DOCKET-50247-69) INDIAN POINT NUCLEAR GENERATING UNIT 2. WNET-102: Technical Report on Steam Generator Tubesheet Cladding. (Westinghouse Electric Corp., Tampa, Fla.). 8 Mar 1972. 182p. Dep. NTIS.

24876 (DOCKET-50249-123) DRESDEN NUCLEAR POWER STATION, UNIT 3. Wiring Error in LPCI Logic Discovered During Surveillance Test. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Mar 1972. 1p. Dep. NTIS.

24877 (DOCKET-50250-78) TURKEY POINT PLANT, UNITS 3 AND 4. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 15 Mar 1972. 112p. (DOCKET-50251-65). Dep. NTIS.

24878 (DOCKET-50250-79) TURKEY POINT PLANT, UNIT 3. Items Still Requiring Resolution. (Division of Compliance (AEC), Atlanta, Ga. Region II). 23 Nov 1971. 3p. Dep. NTIS.

Additional information is presented concerning valves for the chemical and volume control system and safety injection system, pipe fittings in the cooling system, and standards for the main steam line isolation valves. (D.C.C.)

24879 (DOCKET-50250-80) TURKEY POINT, UNITS 3 AND 4. Additional Information Requested in Letter of March 7, 1972. (Florida Power and Light Co.). 16 Mar 1972. 29p. (DOCKET-50251-66). Dep. NTIS.

Requested additional information is presented concerning chemical and thermal discharges from the reactor. The effects of reactor operations on the environment are analyzed. (D.C.C.)

24880 (DOCKET-50255-81) PALISADES PLANT. Correction of Two Errors in Letter of March 22, 1972. (Consumers Power Co., Jackson, Mich.). 24 Mar 1972. 1p. Dep. NTIS.

24881 (DOCKET-50259-40) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 24. (Tennessee Valley Authority, Chattanooga). 13 Mar 1972. 340p. (DOCKET-50260-39; DOCKET-50296-37). Dep. NTIS.

Revised design parameters of the Browns Ferry Power Reactor Units 1, 2, and 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

24882 (DOCKET-50259-41) BROWNS FERRY NUCLEAR POWER STATION. Final Safety Analysis Report, Amendment 25. (Tennessee Valley Authority, Chattanooga). 22 Mar 1972. 49p. (DOCKET-50260-40; DOCKET-50296-38). Dep. NTIS.

Revised and additional data are presented concerning radioactive waste disposal system, electrical system, instrumentation, and communications system. (D.C.C.)

24883 (DOCKET-50259-43) BROWNS FERRY NUCLEAR POWER STATION, UNIT 1. Order Extending Provisional Construction Permit Completion Date Until December 31, 1972. (Division of Reactor Licensing (AEC), Washington, D. C.). 7 Apr 1972. 2p. Dep. NTIS.

24884 (DOCKET-50261-89) H. B. ROBINSON UNIT 2. Emergency Core Cooling System, Reply to Inquiry of February 4, 1971. (Carolina Power and Light Co., Raleigh, N. C.). 16 Feb 1972. 3p. Dep. NTIS.

24885 (DOCKET-50266-63) POINT BEACH NUCLEAR PLANT, UNIT 1. Emergency Core Cooling System, Elimination of Hot Leg Injection. (Wisconsin Electric Power Co., Milwaukee). 10 Mar 1972. 12p. Dep. NTIS.

24886 (DOCKET-50269-49) OCONEE NUCLEAR STATION, UNIT 1. Safety Evaluation, Supplement 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1972. 17p. Dep. NTIS.

Performance evaluation of the emergency core cooling system for the Oconee Power Reactor Unit 1 is presented. (D.C.C.)

24887 (DOCKET-50271-76) VERMONT YANKEE NUCLEAR POWER STATION. Issuance of Facility Operating License DPR-28. (Division of Reactor Licensing (AEC), Washington, D. C.). 21 Mar 1972. 208p. Dep. NTIS.

Operating license for the Vermont Yankee Power Reactor is presented. Technical specifications for reactor operations are included. (D.C.C.)

24888 (DOCKET-50277-43) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Supplementary Information Regarding Control of Combustible Gas Concentrations in Containment. (Philadelphia Electric Co., Pa.). 16 Mar 1972. 10p. (DOCKET-50278-33). Dep. NTIS.

24889 (DOCKET-50277-44) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Orders Extending Provisional Construction Permit Dates to October 1, 1972 and November 30, 1973, Respectively. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Mar 1972. 3p. (DOCKET-50278-34). Dep. NTIS.

24890 (DOCKET-50282-51) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 16. (Northern States Power Co., Minneapolis, Minn.). 10 Mar 1972. 366p. (DOCKET-50306-49). Dep. NTIS.

Revised design parameters of the Prairie Island Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

24891 (DOCKET-50289-53) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 11. (Metropolitan Edison Co., Reading, Pa.). 28 Jun 1968. 32p. Dep. NTIS.

Requested additional information is presented concerning design parameters and stress analysis for the containment structure. (D.C.C.)

24892 (DOCKET-50302-37) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Steps Taken to Correct Items of Apparent Noncompliance in Letter of January 27, 1972. (Division of Compliance (AEC), Atlanta, Georgia. Region II). 16 Mar 1972. 7p. Dep. NTIS.

Corrected quality assurance data requirements for reactor building spray pumps are presented. New inspection forms for recording concrete surface defects in the containment structure are discussed. (D.C.C.)

24893 (DOCKET-50305-34) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 16, Including Supplement to NUS-808. (Wisconsin Public Service Corp., Green Bay). 17 Mar 1972. 173p. Dep. NTIS.

Revised design parameters and operations aspects for the Kewaunee Power Reactor are presented. Hydrological and meteorological data for the reactor site are included. (D.C.C.)

24894 (DOCKET-50312-36) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment 9. (Sacramento Municipal Utility District, Calif.). 10 Mar 1972. 388p. Dep. NTIS.

Revised design parameters of the Rancho Seco Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

24895 (DOCKET-50315-58) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 20. (Indiana and Michigan Power Co., New York). 13 Mar 1972. 356p. (DOCKET-50316-58). Dep. NTIS.

Revised design parameters of the Donald C. Cook Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

24896 (DOCKET-50317-40) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Environmental Report Supplement, Amendment 1. (Baltimore Gas and Electric Co., Md.). 13 Mar 1972. 30p. (DOCKET-50318-39). Dep. NTIS.

Revised information is presented concerning radioactive discharges from the reactors. Modifications to the radioactive waste disposal system are described. (D.C.C.)

24897 (DOCKET-50317-41) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Correspondence Relating to Fabrication and Erection of Condensate and Diesel Fuel Storage Tanks. (Division of Compliance (AEC), Newark, N. J. Region I). 15 Feb 1972. 21p. (DOCKET-50318-40). Dep. NTIS.

24898 (DOCKET-50317-42) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Design Criteria for Intake Structure. (Baltimore Gas and Electric Co., Md.). 19 Feb 1970. 94p. (DOCKET-50318-41). Dep. NTIS.

24899 (DOCKET-50317-43) CALVERT CLIFFS NUCLEAR POWER PLANTS, UNITS 1 AND 2. Final Safety Analysis Report, Revision 8, Amendment 19. (Baltimore Gas and Electric Co., Md.). 24 Mar 1972. 122p. (DOCKET-50317-43). Dep. NTIS.

Revised design parameters of the Calvert Cliffs Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. Design requirements for transmission line towers are presented. (D.C.C.)

24900 (DOCKET-50321-32) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Schedule for Submitting Response to Request for Additional Information. (Georgia Power Co., Atlanta). 10 Mar 1972. 2p. Dep. NTIS.

24901 (DOCKET-50324-35) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Design Report 11, Addendum A, Containment Large Opening Design. (Carolina Power and Light Co., Raleigh, N. C.). 22 Mar 1972. 20p. (DOCKET-50325-36). Dep. NTIS.

24902 (DOCKET-50338-40) NORTH ANNA POWER STATION, UNITS 1, 2, 3, AND 4. Applicants Environmental Report Supplement. (Virginia Electric and Power Co., Richmond). 11 Oct 1971. 492p. (DOCKET-50339-38; DOCKET-50404-9; DOCKET-50405-9). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Biological, geological, hydrological, and meteorological data for the reactor site are included. (D.C.C.)

24903 (DOCKET-50338-41) NORTH ANNA POWER STATION, UNITS 1, 2, 3, AND 4. Applicants Environmental Report Supplement. (Virginia Electric and Power Co., Richmond). 15 Mar 1972. 476p. (DOCKET-50339-39; DOCKET-50404-10; DOCKET-50405-10). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactors is included. Biological data for the reactor site are presented. (D.C.C.)

24904 (DOCKET-50344-26) TROJAN NUCLEAR PLANT. Several Activities Which Appeared to be in Nonconformance With Preliminary Safety Analysis Report. (Division of Compliance (AEC), Berkeley, Calif. Region V). 17 Mar 1972. 3p. Dep. NTIS.

Corrections for construction procedures for the reinforced concrete containment structure are described. (D.C.C.)

24905 (DOCKET-50348-37) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Steps Taken to Correct Items of Apparent Noncompliance Listed in Letter Dated January 24, 1972. (Division of Compliance (AEC), Atlanta, Ga. Region II). 1 Mar 1972. 6p. (DOCKET-50364-31). Dep. NTIS.

Corrected welding procedures are described to conform to quality assurance requirements for construction. (D.C.C.)

24906 (DOCKET-50373-17) LA SALLE COUNTY STATION, UNITS 1 AND 2. Environmental Report, Supplement 4. (Commonwealth Edison Co., Chicago, Ill.). 20 Mar 1972. 26p. (DOCKET-50374-17). Dep. NTIS.

Requested additional information is presented concerning radioactive and thermal discharges from the reactors. (D.C.C.)

24907 (DOCKET-50382-19) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 12. (Louisiana Power and Light Co., New Orleans). 13 Mar 1972. 101p. Dep. NTIS.

Revised and additional information is presented concerning design parameters and operation aspects of the reactor. Requested additional data are included concerning earthquake stress analysis for piping systems and structures. (D.C.C.)

24908 (DOCKET-50390-10) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 4. (Tennessee Valley Authority, Chattanooga). 9 Mar 1972. 99p. (DOCKET-50391-10). Dep. NTIS.

Revised design parameters of the Watts Bar Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

24909 (DOCKET-50397-13) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 3. (Washington Public Power Supply System, Richland). 10 Mar 1972. 98p. Dep. NTIS.

Revised design parameters of the Hanford Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

24910 (DOCKET-50398-9) MENDOCINO POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3. (Pacific Gas and Electric Co., San Francisco, Calif.). 10 Mar 1972. 425p. (DOCKET-50399-9). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. Geological and seismological data for the reactor site are included. (D.C.C.)

24911 (DOCKET-50400-13) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 4. (Carolina Power and Light Co., Raleigh, N. C.). 14 Mar 1972. 278p. (DOCKET-50401-13; DOCKET-50402-13; DOCKET-50403-13). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects for the Shearon Harris Power Reactor Units 1, 2, 3, and 4. (D.C.C.)

24912 (DOCKET-50400-14) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 5; Environmental Report, Revised. (Carolina Power and Light Co., Raleigh, N. C.). 16 Mar 1972. 429p. (DOCKET-50401-14; DOCKET-50402-14; DOCKET-50403-14). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Environmental aspects of transmission lines are described. Cost-benefit analysis for reactor operation is presented. (D.C.C.)

24913 (NP-19187) SITING THERMAL POWER PLANTS IN CALIFORNIA. (California State Resources Agency, Sacramento). 15 Feb 1970. 98p.

It is estimated that ten California sites in addition to those presently in the state are required for the electric generating capacity to be needed by 1990. An outline is presented concerning acquisition and use of these sites. Information and discussions on siting, environmental requirements, and power requirements are included. (J.R.D.)

24914 NUCLEAR RADIATION MOLEHILL. Landis, John W. (Gulf General Atomic Co., San Diego, Calif.). Proc. Amer. Power Conf.; 33: 35-41(1971).

From thirty-third annual meeting on American Power Conference; Chicago, Ill. (20 Apr 1971).

The AEC standards for protection against radiation are discussed. The radiation release limits for nuclear power reactors are examined in the light of typical nonoccupational radiation exposures to the general population. It is concluded that routine release of radioactivity from power reactors does not constitute a major danger to the public. (H.D.R.)

24915 SITING OF NUCLEAR POWER PLANTS IN CZECHOSLOVAK SOCIALIST REPUBLIC. Beranek, Jiri (Czechoslovak Atomic Energy Commission, Prague); Kriz, Zdenek; Chochlovsky, Igor; Raisigl, Cestmir; Sevc, Josef. Jad. Energ.; 18: No. 1, 2-8(Jan 1972). (In Czech).

For actual siting of nuclear power plants two different approaches are used: the siting in relatively isolated locations, i. e. nuclear power plants without containment, surrounded by exclusion areas, with maximum emphasis on reliability of all components; and the siting of nuclear power plants (particulary for heating purposes) directly in highly populated areas with great consumption of electricity and heat. The second approach demands the use of a well-proven type of reactor with double containment and all engineered safeguards. 7 references. (auth)

24916 SAFETY-RELATED OCCURRENCES REPORTED IN OCTOBER-NOVEMBER 1971. Scott, R. L. Nucl. Safety; 13: No. 2, 136-49(Mar-Apr 1972).

24917 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety; 13: No. 2, 156-74(Mar-Apr 1972).

Propulsion and Auxiliary Power Reactors

Refer also to abstract 23274.

24918 (GULF-GA-A-10535) 40 kWe THERMIONIC POWER SYSTEM FOR A MANNED SPACE LABORATORY. Gietzen, A. J.; Fisher, C. R.; Heath, C. A.; Homeyer, W. G.; Hackney, M. R.; Merrill, M. H.; Ingber, J. F. (Gulf General Atomic Co., San Diego, Calif.). 1 Jul 1971. Contract AT(04-3)-840. 213p. Dep. NTIS.

A thermionic reactor power system for application to a long-lived, manned space laboratory is described. The design net power is 40 kW(e); however, the system can be operated at any power up to 55 kW(e) at beginning-of-life (BOL) and 40 kW(e) at end-of-life (EOL). The design objective is 5 years, i.e., no limits known to be less than five years are included in the design. The reactor contains thermionic fuel elements, in which electrical power is produced, and U-ZrH driver fuel elements. The thermionic converter design is the same as that presently being tested in the Gulf General Atomic thermionic test reactor. There are enough fuel elements in the reactor to provide a high degree of redundancy at BOL (35%) at the nominal 40 kW(e) design point. Reject heat from the fuel elements is removed by forced convection NaK loops to the primary radiator where it is radiated to space at about 800°K (980°F). Electrical power output from the reactor at about 9 V is carried to a modular power conditioning system where it is processed to higher voltage for transmission to the spacecraft. Radiation protection is provided by LiH neutron shielding and W gamma shielding in a shaped 4π configuration, i.e., the reactor is shielded on all sides but not to equal extent. An alternate power system configuration for cable tether mounting applying the same reactor design is also presented. This configuration offers reduced total system mass and improved electrical performance. Performance characteristics of a system applying a reactor using only thermionic fuel elements and no driver elements are also given. (45 references) (auth)

24919 (TID-5464(Pt.1)) NUCLEAR AUXILIARY POWER PLANT SUBSYSTEM STUDY PROGRAM. DEVELOPMENT PLAN. PART I. GENERAL DESCRIPTION, SCHEDULING, AND COSTS. (Lockheed Aircraft Corp., Palo Alto, Calif. Missile Systems Div.). 31 Dec 1956. Contract AT(04-3)-98. 15p. (MSD-2050). Dep. NTIS.

Declassified 19 Oct 1971.

The development time schedule and funding schedule for the nuclear auxiliary power plant subsystem of the advanced reconnaissance system orbital spacecraft are presented. (D.C.C.)

24920 (TID-21987) FEASIBILITY STUDY OF NUCLEAR-POWERED FLYING CRANE HELICOPTERS. Sullivan, R. J. (Hughes Tool Co., Culver City, Calif. Aircraft Div.). 23 Oct 1958. Contract [AT(11-1)-171]. 81p. (X-381). Dep. NTIS.

Declassified 21 Oct 1971.

Preliminary studies were conducted on the feasibility of nuclear-powered flying crane helicopters based on the direct cycle reactor system. Rotor tip jet drives of the hot, cold, and mixed cycle systems were investigated. The feasibility of a nuclear geared turbine helicopter and of the use of a combination petroleum-nuclear powerplant was examined. Results of the studies and recommendations for further work are presented. (H.D.R.)

24921 (TID-21989) REACTOR ANALYSIS NUCLEAR HEATING METHODS. Maier, R. J. (comp.) (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). 26 Feb 1960. Contract [AT(11-1)-171]. 117p. (DCR-174). Dep. NTIS.

Declassified 21 Oct 1971.

Results of the various calculations in the form of heating rates and distributions for the DIOIE reactor components are presented. Various methods of analysis used are summarized. Calculated average heating rates and distributions are given for each active core component as well as for end and radial reflectors. Separate distributions in the major components are given for each heating source, i.e., neutron, gamma, etc., as well as over-all total heating distributions. Results are given in watts/watt and watts/watt-gm for each component. Afterheating rates are given for 12 and 50 hours of operation at 50 MW. A discussion of some of the uncertainties and assumptions is given along with other pertinent information (drawings, charts, tables, etc.) necessary to understand the methods and to apply the results. The energy released from all sources and the resulting energy depositions are tabulated, and show that 99.8% of all fission energy remains in the reactor. 23 references. (auth)

24922 (TID-22305) GAS-COOLED REACTOR EXPERIMENT. PRELIMINARY EVALUATION OF BERYLLIUM AND BERYLLIUM

OXIDE HETEROGENEOUS REACTORS. (Aerojet-General Corp., Azusa, Calif.). 30 Jul 1957. Contract AT(10-1)-880. 65p. Dep. NTIS.

Declassified 20 Oct 1971.

The potential use of Be or BeO as moderator in a heterogeneous reactor for the Gas Cooled Reactor Experiment is analyzed. Two preliminary system designs, one for each material, are presented. The associated problems are investigated. (auth)

24923 NUCLEAR POWER SYSTEMS FOR SPACE APPLICATIONS. Lubarsky, Bernard (Lewis Research Center, Cleveland). Advan. Nucl. Sci. Technol.; 5: 223-323(1969).

Nuclear power systems for space applications are briefly surveyed. The factors which cause nuclear space power systems to differ from ground systems and the relation of nuclear to chemical and solar space power systems are discussed. The isotope and reactor power systems of greatest current interest are described, and waste heat radiators are discussed. (93 references) (H.D.R.)

24924 NUCLEAR REACTOR. Hobson, Robert R.; Griffin, Thomas E. (to United States Atomic Energy Commission). U. S. Patent 3,623,946. 30 Nov 1971. Filed 22 Jun 1965.

A nuclear reactor is described which comprises: an elongated cylindrical core longitudinally divided into quadrants, each core quadrant being neutronically subcritical; means for flexibly fastening together two diametrically opposed quadrants at one end of said core and for retaining the remaining two quadrants in a fixed position; means for driving the free ends of said flexibly fastened quadrants apart and for returning them together; means for controlling the reactivity of said reactor core; and, means for removing the energy generated by said reactor core. (Official Gazette)

24925 LONG-RANGE OUTLOOK FOR NUCLEAR SHIPS. At. Jap.; 15: No. 5, Suppl. 2, 1-12(May 1971).

Bigger and faster ships are built in order to improve economic performance. Accordingly development of more economical and powerful engines is urgently needed. No nuclear ship has been built to date for commercial service, but efforts to develop economical marine reactors must not be spared. World population is expected to grow to 6.5 billion by 2,000, and sea-borne traffic to 17 billion tons. Tonnage of ships to be launched in 2000 will be 127 million GT. Rapidly increasing demand for sea transport can be met by development of economical LWRs, followed by high temperature gas-cooled reactors. By 1980, nuclear ships will be economically competitive with conventional counterparts at engine outputs from 50,000 to 150,000 hp. 280 nuclear ships are expected to be built in Japan by the year 2000. Nuclear powered ships must offer adequate safety and reliability, so that they can enter any port freely. For such extensive use of nuclear ships, secure acquisition of nuclear fuel is indispensable, and about 100,000 ST of U_3O_8 must be in stock by 2000. A joint program with West German industry—which already operates a nuclear merchant ship and collects data on her—is very useful for Japanese studies of operation of such ships. (Japan)

Control and Instrumentation

Refer also to abstracts 22914 and 24943.

24926 (TID-5885) A BEARING EVALUATION FOR IN-PILE APPLICATION. Mattrella, U. (Pratt and Whitney Aircraft, Middletown, Conn.). 7 Jan 1958. 10p. (TIM-458). Dep. NTIS.

Declassified 19 Oct 1971.

The results of the 1000 hour bearing endurance tests for the aircraft reactor fused salt pump drive motor indicated that dry (non-lubricated) bearing operation was feasible in a salt vapor-helium atmosphere when operated at the speeds and under the loads described. In particular, the results of the bearing wear examinations indicated that those bearing types that incorporated organic separators were superior to those with machined, metallic separators or those with no separators. In the event that the organic separators would not withstand radiation, the machined metallic separators would take preference. The successful completion of each bearing's endurance test was not the only condition to be fulfilled in selecting a bearing for in-pile use. The amount of overall bearing wear and distortion resulting from the endurance tests plus the radiation resistance of the bearing's components were facets also to be considered. For instance, the high cobalt content in the Star J Stellite bearing material limited its application in-pile. Therefore, on the basis of the requirements described above it is recommended that a bearing composed of M-2 tool steel alloy balls and races with an Inconel "X" silver plated separator be used. (auth)

24927 (TID-21988, pp 5-41) DESCRIPTION AND PRE-ANALYSIS OF PROPOSED BSF NUCLEAR HEATING MEASUREMENTS. Carver, J. G. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (XDC-58-1-51).

Declassified 20 Oct 1971.

Proposed nuclear heating measurements in the ORNL Bulk Shielding Facility are described. Results of the preanalysis, based on point-kernel calculations, are presented. 12 references. (auth)

24928 (TID-21988, pp 42-70) POINT KERNEL CALCULATIONS OF CORE GAMMA HEATING IN THE BSF NUCLEAR HEATING EXPERIMENT. Casper, A. W. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (XDC-58-8-234).

Declassified 20 Oct 1971.

The results of point kernel calculations of core gamma heating in the configurations used in the nuclear heating experiments at the ORNL Bulk Shielding Facility are presented. Several different ways of calculating and using the point kernel energy flux to determine heat deposited are described and discussed. 11 references. (auth)

24929 (TID-21988, pp 71-90) INTERIM REPORT ON BUILDUP FACTORS FOR HEATING CALCULATIONS. Carver, J. G. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (DC-58-10-161).

Declassified 20 Oct 1971.

Several of the different types of buildup factors which have been defined and tabulated are discussed and the criteria for choice of a particular type for use in computing gamma ray heating rates are examined. (auth)

24930 (TID-25539) PROPOSED D140E1 AFTERHEAT REMOVAL SYSTEM. Hemby, J. R. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). 23 Jun 1960. 7p. Dep. NTIS.

Declassified 19 Oct 1971.

The proposed cooling air flow rates required to remove the decay heat accumulation in the various powerplant components following shutdown from specific operating histories and post-shutdown conditions are analyzed. (auth)

24931 EXPERIENCES AND PROBLEMS ON DESIGN AND CONSTRUCTION OF RADIATION SHIELDINGS. 3. SHIELDING IN NUCLEAR POWERED SHIPS. Kawai, Yasuhiko (Japan Nuclear Ship Development Agency, Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 7, 396-400(Jul 1971). (In Japanese).

The requirement for shielding in nuclear powered ships is very strict. The nuclear ship "Mutsu" is an experimental ship of 130 m long and 8,200 gt, and her reactor is a PWR of 36 MW thermal output. The German nuclear ship "Otto Hahn" is an ore carrier with a PWR of 40 MW thermal output. The shielding in these ships is described briefly. Primary shielding in Mutsu is made of concrete for upper and middle parts, of steel water tank for lower part, and of lead for the bottom. Secondary shielding is made of a double layer of lead and polyethylene for the top and concrete for the side of a containment vessel. Problems in the shielding of marine reactors are curtailment of weight and space, improvement of design accuracy, and development of handy and reliable computing codes. (Japan)

Safety

Refer also to abstract 24974.

Process Heat and Desalination Reactors

24932 (INIS-mf-172, pp 15-31) NUCLEAR DISTRICT HEATING DEVELOPMENT IN SWEDEN. Margen, P. H. (Aktiebolaget Atomenergi, Stockholm (Sweden)). 1970. (CONF-690565-5). INIS.

From Nuclear heating symposium; Tatranska Lomnica, Czechoslovakia (13 May 1969).

The prospects are reviewed of nuclear district heating in Sweden and problems are discussed affecting this system. The project is described of the Stockholm Electricity Board to overcome the problem of high costs by siting a district heating reactor inside the Stockholm conurbation. A description is presented of the projected 500 MW(e) reactor to be commissioned in 1974-1975. The design envisages a BWR steel pressure vessel in a concrete containment placed underground. Discussed is the future development of PCPV reactors that will be constructed underground. The first of these reactors is to be commissioned in 1975. Preliminary economic considerations indicate that a combined electricity and heat production by a common-size power plant would result in savings of 10 to 15%. (INIS)

24933 (INIS-mf-172, pp 55-78) NUCLEAR POWER AND DISTRICT HEATING PLANT. Gallois, G. (Societe Belge pour

l'Industrie Nucleaire, Brussels). 1970. (CONF-690565-2). INIS.

From Nuclear heating symposium; Tatranska Lomnica, Czechoslovakia (13 May 1969).

A brief description is given of a dual-purpose nuclear power heating plant with a total thermal output of 500 MW(t), equipped with a light water Vulcain reactor. The description includes the design of a reference plant based on the experience gained from the Vulcain Research and Development Program. The main primary components are described and thermal and nuclear data are reviewed. The basic reference flow-sheet is also developed. Assuming that the plant is under base load and that steam and water consumptions are steady, a back-pressure turbine system without condensing turbines is installed. Bleeding points provide overheating of the process steam. The net electrical power amounts to 57 MW. In view of the fact that nuclear heating plants should be close to population centers if steam and water distribution costs are to be reduced, several plant arrangements are described, e.g. multiple barrier containments. (auth) (INIS)

24934 (INIS-mf-172, pp 97-121) NUCLEAR REACTOR FOR HEAT AND POWER SUPPLY. Hulovec, J.; Mueller, V. (Skoda [Works], Pilsen (Czechoslovakia)). 1970. (CONF-690565-3). INIS.

From Nuclear heating symposium; Tatranska Lomnica, Czechoslovakia (13 May 1969).

A pressurized water reactor of the VVER type is considered for heat and power supply purposes. Parameters of this reactor, and some construction elements of the primary circuit are described. In view of the fact that the reactor should be sited near a densely populated area, a brief description is given of the design of the double containment. (auth) (INIS)

24935 (NP-19212) NUCLEAR AGRO INDUSTRIAL COMPLEX STUDY (NUPLEX). PHASE I: IDENTIFICATION OF RESEARCH REQUIREMENTS. Bradley, J. R.; Davison, R. R.; Denison, J. S.; Meier, W. L., Jr.; Meinke, W. W.; Runkles, J. R.; van Bavel, C. H. M.; Wick, R. S.; Wainerdi, R. E. (Texas Agricultural and Mechanical Univ., College Station). 1 Nov 1969. 72p.

The potentialities for the State of Texas of very large concentrated sources of electric power, desalted seawater, and the chemicals which can be produced in associated operations are examined. The Nuplex concept consists of a large complex containing a power reactor, electricity production, water desalination, chemical production, agriculture, and associated activities. Various areas of study are identified and discussed in which additional research is needed to provide basic design criteria for the Nuplex. (30 references) (H.D.R.)

Operation and Economics

24936 (INIS-mf-172, pp 33-54) DESCRIPTION OF A CONVENTIONAL DISTRICT HEATING PLANT AND FEASIBILITY OF USING A NUCLEAR POWER SOURCE. Maldague, P. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1970. (CONF-690565-4). INIS.

From Nuclear heating symposium; Tatranska Lomnica, Czechoslovakia (13 May 1969).

A typical district heating plant is described, sited at Verviers, Belgium, where the grid is supplied by a modern dual-purpose unit producing 100 T/hr of steam for industrial and household uses, and 24 MW(e) of by-product electricity. Main technical aspects of the plant are discussed, including characteristics of the grid, of the boilers and turbine generators, heat consumption, and production diagram. The investment and operation costs of the base load unit are analyzed. A similar unit producing 560 T/hr of steam, i.e., 370 Gcal/hr, and 134 MW(e) of electricity is considered as a hypothetical case characterized by specific local conditions existing e.g. in Czechoslovakia. The investment and production costs of this unit are estimated. As an alternative, a nuclear unit of the PWR type with the same steam output is considered. Its economic characteristics are estimated and compared to the conventional unit. (auth) (INIS)

24937 (RT/ING-(71)15) ROVI PROMOTIONAL STUDY: CATANIA INDUSTRIAL AREA. PART I. Berardinelli, L.; Cesari, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 7 Sep 1971. 108p. (In Italian). Dep. NTIS (U. S. Sales Only).

Data are presented on actual water resources of Catania city and of its industrial areas. Estimated water requirements in 1975 are listed. Existing and foreseen agriculture and industrial activities in the Catania surroundings are described. The opportunity to install a desalting plant served by a ROVI nuclear reactor is evaluated. (6 references) (auth)

Safety and Siting

24938 (INIS-mf-172, pp 129-42) SAFETY ANALYSIS OF NUCLEAR HEATING PLANT LOCATED IN HIGHLY POPULATED AREA. Storrer, J. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1970. (CONF-690565-7). INIS.

From Nuclear heating symposium; Tatranska Lomnica, Czechoslovakia (13 May 1969).

The safety problems associated with a water-cooled nuclear power station and its siting in a highly populated area are reviewed as well as the problems of heat supply. It is shown that all risks of contamination of the heat distribution grid can be avoided for all foreseeable accidents without undue cost penalty. (auth) (INIS)

Research and Test Reactors

Refer also to abstracts 23286, 23307, 24927–24929, 25008, and 25010.

24939 (ARH-600(Vol.3)) CRITICALITY HANDBOOK. VOLUME III. Blyckert, W. A.; Carter, R. D.; Ridgway, K. R. (Atlantic Richfield Hanford Co., Richland, Wash.). 1 Sep 1971. Contract AT(45-1)-2130. 122p. Dep. NTIS.

Calculated and experimental criticality data are presented for homogeneous, heterogeneous, interacting, and poisoned systems. (H.D.R.)

24940 (IRI-130-131-71-1) FLUX-, POWER- AND BURNUP DETERMINATION FOR POOL-TYPE REACTORS. Brand, P.; van Dam, H.; Duin, G. J.; Kleijn, H. R.; Rijks, H. J.; de Vries, J. W. (Interuniversitair Reactor Instituut, Delft (Netherlands)). Sep 1971. 100p. Dep. NTIS (U. S. Sales Only).

A survey is presented of the theoretical and experimental aspects of power calibration of pool-type reactors. A description is given of experimental techniques and procedures based on the use of activation detectors. An analysis of the evaluation of spectrum dependent effective cross sections of both core and detector materials is presented. A description is given of the FORTRAN code PEP designed to transform the measured foil activities into flux density distributions, power distributions and peaking factors. Burnup calculations for highly enriched reactor cores are described. A listing of the PEP program, together with input and output for a sample problem and an error analysis, is presented. (auth)

24941 (ORNL-TM-3730) HETEROGENEITY EFFECTS IN THE ZPR-III ASSEMBLY 48 BY MONTE CARLO. Cramer, S. N. (Oak Ridge National Lab., Tenn.). 8 Mar 1972. 25p. Dep. NTIS.

Geometric heterogeneity effects in the standard drawer of ZPR-III Assembly 48 were investigated by Monte Carlo. Results are given for one-, two-, and three-dimensional mock-ups of the drawer and compared with one-dimensional discrete ordinates calculations. Full core eigenvalue evaluations are also presented. The Monte Carlo calculations were performed with a version of the ESP code which allows the exact description of the plate-drawer assembly through the use of the fictitious scattering transport model and a generalized array geometry routine. 7 references. (auth)

24942 (SRARI-102) COMPARISON OF HIGH-FLUX RESEARCH REACTORS. Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The criteria for the comparison of the research reactors of various types with high neutron fluxes, intended substantially for specimen irradiations with neutron absorption in them, have been proposed. The comparison of the high-flux reactors of two types (with light water and neutron trap, with heavy water and low fuel concentration in the core) is given and the conclusion is drawn about their application depending on operation program. 8 references. (auth)

24943 (TID-21988) BULK SHIELDING REACTOR NUCLEAR HEATING EXPERIMENTS. Maier, R. J. (comp.) (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). 26 Feb 1960. Contract [AT(11-1)-171]. 304p. (DCR-173). Dep. NTIS.

Declassified 20 Oct 1971.

Included are 9 reports on nuclear heating of shielding systems of potential application in aircraft reactors. The experiments were conducted in the Bulk Shielding Facility on various slab shield arrays. A separate abstract was prepared for each report. (H.D.R.)

For abstracts of individual papers see: 24927–24929, and 24944–24949.

24944 (TID-21988, pp 91-118) COMPARISON OF BSF WATER CENTERLINE MEASUREMENTS WITH PREDICTIONS.

Casper, A. W. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (XDC-58-11-208).

Declassified 20 Oct 1971.

Measurements of fast neutron and gamma ray dose rates in water along the centerline of the Bulk Shielding Reactor are compared with predictions made using three computer programs. It is found that the predictions are quite sensitive to the assumptions made concerning power distribution, and that the more accurate descriptions of the source lead to predictions which agree with measurements to within 20 percent throughout thickness ranges as large as 100 cm of water. 8 references. (auth)

24945 (TID-21988, pp 119-33) POWER CALIBRATION FOR BSR LOADING 33. Johnson, E. B. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.).

Declassified 20 Oct 1971.

BSR Loading 33 consisted of an essentially 5 by 6 fuel element array completely reflected by water. It was controlled by means of two boron carbide shim-safety rods and a Type 347 stainless steel regulating rod with an 87-mil wall. The critical mass was about 3.4 kg of ^{235}U, with an excess reactivity for the clean cold loading of about 0.6%. The total mass in the initial loading was 3.6 kg of ^{235}U. Loading 33 was initially assembled in November, 1954, from clean cold fuel elements. The power calibration was made during the first series of runs at power levels appreciably above 1 watt. The results of the calibration are presented. (auth)

24946 (TID-21988, pp 134-81) CALCULATION OF NEUTRON INTERACTIONS IN THE GE-BSF SHIELDING ARRAYS FOR USE IN HEATING COMPUTATIONS. Krumbein, A. D. (Nuclear Development Corp. of America, White Plains, N. Y.). (NDA-2092-7).

For General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.

Declassified 20 Oct 1971.

Neutron flux values as a function of distance along the centerline of the GE-BSF shielding arrays were obtained from both multigroup and Monte Carlo machine calculations. These neutron fluxes were used to compute: (1) capture gamma ray sources, (2) inelastic gamma ray sources, (3) charged particle sources, and (4) neutron energy deposition from elastic scattering, as a function of neutron energy and distance along the centerline of the shielding arrays. The results from the NDA multigroup Datatron code (STAR) and its Monte Carlo Datatron code (MIS) were compared and found to agree quite well, except in the highest energy region used (1.32 MeV to 10.0 MeV), where discrepancies of a factor of two were found. 18 references. (auth)

24947 (TID-21988, pp 182-214) REPORT OF DATA FROM FIRST NUCLEAR HEATING MEASUREMENTS IN BULK SHIELDING FACILITY. Maier, R. J. Jr. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (XDC-58-8-61).

Declassified 20 Oct 1971.

A brief description is presented of the first series of nuclear heating experiments performed in the ORNL Bulk Shielding Facility in which heating rates were obtained for three, three-material slab configurations. The analytical methods used in data reduction are described, and the results are presented, together with some discussion of the limitations on accuracy of the results. (auth)

24948 (TID-21988, pp 215-33) REPORT OF DATA FROM SECOND NUCLEAR HEATING MEASUREMENTS IN BULK SHIELDING FACILITY. Maier, R. J. Jr. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (XDC-59-6-34).

Declassified 20 Oct 1971.

A brief description is presented of the second and final series of nuclear heating experiments performed in the ORNL Bulk Shielding Facility, in which heating rates were obtained for three 3-material slab configurations. The analytical methods used in data reduction are described and the results are presented, together with some discussion of the limitations on accuracy of the results. (auth)

24949 (TID-21988, pp 234-303) COMPARISON BETWEEN CALCULATED AND MEASURED NUCLEAR HEATING RATES IN BSF EXPERIMENTS, SECOND SERIES. Maier, R. J. Jr. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). (XDC-60-2-64).

Declassified 20 Oct 1971.

The heating rates from the second series of BSF nuclear heating measurements were computed by combining calculations of core gamma heating (done previously by point kernel techniques) with diffusion theory methods of calculating neutron and secondary gamma heating. For calculations of neutron induced effects using diffusion theory alone, the calculated heating to measured heating ratios range from 1.0 to 2.3. For calculations where the diffusion theory results were normalized to an Albert Welton point kernel, the ratios ranged from .35 to 1.3. (auth)

24950 OBJECTIVES AND DESIGN OF THE FAST FLUX TEST FACILITY. Astley, E. R.; Finch, L. M.; Hofmann, P. L. (Battelle-Northwest, Richland, Wash.). Advan. Nucl. Sci. Technol.; 5: 1-50(1969).

The history and needs for development of the Fast Flux Test Facility are summarized. The Fast Test Reactor design aspects discussed include driver fuel, kinetics, core configuration, mechanical design parameters, and fuel handling facilities. (21 references) (H.D.R.)

24951 DETERMINATION OF NEUTRON MULTIPLICATION FACTORS AS A FUNCTION OF TEMPERATURE WITH THE HIGH TEMPERATURE LATTICE TEST REACTOR. Richey, C. R.; Oakes, T. J. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Sci. Eng.; 47: No. 1, 40-58 (Jan 1972).

The High Temperature Lattice Test Reactor (HTLTR) is a unique critical facility specifically built for studying reactor lattices at temperatures up to 1000°C. A description of the reactor is given and the unpoisoned technique for determining k_∞^*, the neutron multiplication factor, from the ratio of the reactivity coefficients of a test sample of a neutron multiplying medium and a normalizing thermal neutron absorber is discussed. Comparisons of k_∞^* as measured by the unpoisoned method and the Physical Constants Testing Reactor null reactivity method are given for a natural UO_2-2.2 wt % PuO_2 (8% ^{240}Pu) graphite lattice and for a UO_2 (97.42 wt % ^{233}U)-$^{232}ThO_2$-C fuel element in a graphite array. Experimental values for the neutron multiplication factor were determined as a function of temperature using the HTLTR for a graphite moderated lattice fueled with a $^{235}UC_2$-$^{232}ThO_2$-C fuel mixture. (21 references) (auth)

24952 KEMA SUSPENSION TEST REACTOR. II. OBJECTIVES AND DEVELOPMENT OF THE KEMA SUSPENSION REACTOR PROJECT. Hermans, M. E. A. (N. V. KEMA, Arnhem, Netherlands). Ingenieur (Utrecht); 83: A951-4(17 Dec 1971). (In Dutch).

The objectives and the development of the KEMA Suspension Reactor Project are presented and evaluated in their different stages. The arguments are enumerated which led to the design and construction of the KEMA Suspension Test Reactor and, finally, the status of the project is described with the envisaged program for operation of the KSTR. (auth) (Netherlands)

24953 KEMA SUSPENSION TEST REACTOR. IV. THE DESIGN AND CONSTRUCTION OF THE KEMA SUSPENSION TEST REACTOR. Wolf, H. (N. V. KEMA, Arnhem, Netherlands). Ingenieur (Utrecht); 83: W135-42(17 Dec 1971). (In Dutch).

Against the background of the development program for an aqueous homogeneous suspension reactor, an outline is given of the general aims to be fulfilled by this experimental unit. The more essential systems and components are surveyed, as well as some of the techniques applied for measurement and control of reactor and suspension conditions. Some details of the design and some constructional procedures are mentioned that have been determined largely by the properties of the suspension or by the specific requirements for this experimental critical facility. (auth) (Netherlands)

24954 EXPERIMENTS AND CONSIDERATIONS FOR THE DESIGN AND THE POWER INCREASE OF FRG-2. Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt, mbH, Geesthacht, Ger.). Atomkernenergie; 18: No. 4, 287-94(Dec 1971). (In German).

In material testing reactors a very high fast neutron flux density in a large number of irradiation positions is desired. To reach this for the FRG-2 many measurements have been done to determine the nuclear design (microstructive distribution of the thermal neutron flux density, dependence of the form factor on shim rods, capsules, position of capsules, reflector and complex core-configuration). Combined with a new thermodynamic design and design considerations an increase of the reactor power and of the fast neutron flux density of 50% is possible. It can be shown, that for a further development of the FRG-2 (^{235}U content of the fuel elements, total number and design of the shim rods, control rod program, compact core configuration, reflector, condition for the power scram) the fast neutron flux density can be increased by a factor 1.65. The fast neutron flux density in the irradiation positions of the FRG-2 is then max 2.5 to 3.0×10^{14} cm^{-2} s^{-1} for a reactor power of 22 to 25 MW, which depends on the reactor lattice and the yearly variation of coolant conditions. (12 references) (auth)

24955 SLOW NEUTRON SPECTRAL CHARACTERISTICS OF THE VVR-M CRITICAL ASSEMBLY. Nikonov, A. V.; Klimentov, V. B. At. Energ. (USSR); 32: No. 1, 64-5(Jan 1972). (In Russian).

A determination of the effective neutron temperature was made using foils of Lu, In, and Dy of thicknesses 0.07, 1.20, and 0.84 mg/cm^2, respectively, in a thermal column at a distance 70 cm from the edge of the reactor core. Values of the Cd ratio were determined for ^{164}Dy and ^{115}In, making allowance for neutron suppression by the Cd. Thus spectral characteristics of the VVR-M reactor lattice were analyzed at three points including the surface of a fuel element. (9 references) (K.S.W.)

24956 PULSED-SOURCE EXPERIMENTS IN A REFLECTED COUPLED-CORE REACTOR. I. REACTIVITY MEASUREMENTS. McDonnell, F. R N.; Harris, M. J. (Victoria Univ. of Manchester Eng.). J. Nucl. Energy; 26: No. 3, 113-28(Mar 1972).

The behavior was studied of the Universities Research Reactor when subjected to pulses of fast neutrons. The URR is an enriched-uranium, water-cooled and moderated, graphite-reflected system, the core consisting of two coupled fuel slabs spaced 1 ft apart and containing approximately 3300 g of ^{235}U. The pulsed source was located symmetrically relative to the core slabs (so that the coupled-core nature of the reactor was suppressed) and the results were analyzed using the more conventional point-reactor models. A reflector decay mode, as predicted by a three-region Cohn model was not observed. The delayed critical prompt decay constant of the URR was found to be 33.5 ± 0.6 sec^{-1}. The experiments showed that, for sub-critical core loadings in a highly reflected system such as the URR, the data is analyzed most readily and reliably by the Simmons–King method supplemented by calculated changes in the generation time. The Gozani method corrected for kinetic distortion was found to be the most suitable of the modified pulse techniques. METHUSELAH II—GOG multi-group-diffusion poison-removal calculations gave prompt and delayed flux distributions which accounted well for the observed spatial dependence of the modified-pulse-technique reactivities. The experimental and calculated decay constants, although substantially in agreement at critical, diverged by as much as 15–25% for the subcritical core loadings. (auth) (UK)

24957 PULSED-SOURCE EXPERIMENTS IN A REFLECTED COUPLED-CORE REACTOR. II. CORE COUPLING MEASUREMENTS. McDonnell, F. R. N.; Harris, M. J. (Victoria Univ. of Manchester, Eng.). J. Nucl. Energy; 26: No. 3, 129-40(Mar 1972).

Experiments are described in which the URR, a reflected couple-core reactor, was subjected to neutron pulses derived from a source positioned asymmetrically with respect to the two core slabs, i.e., in such a position as to emphasize the coupled nature of the two-core reactor. The observed response was analyzed in terms of a variety of different coupling models and was found to be described very satisfactorily by simple one-group two-point models of the Baldwin type. The coupling reactivity was thus found to be 6.40 ± 0.17$, a value which was insensitive to core fuel loading. The delay time between cores was found to be 0.33 ± 0.16 msec, which compares favorably with values obtained by other techniques. Narrow channel-width experiments failed to reveal any oscillatory response in the passive core as predicted by some authors. (auth) (UK)

Control and Instrumentation

Refer also to abstracts 22911 and 24791.

24958 (BNWL-B-32) SURVEILLANCE FOR VERTICAL SAFETY RODS AT HTLTR. Clark, R. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 28 Oct 1970. 11p. Dep. NTIS.

Operation of the High Temperature Lattice Test Reactor (HTLTR) over the temperature range from 20°C to 1000°C has resulted in unpredicted material deformations which occur in the vertical safety rods (VSR). These material deformations have resulted in a malfunction of the VSRs, a potentially hazardous condition. To eliminate the hazard, a new VSR poison plate was designed. A model was constructed and tested under prototypical conditions. The test results showed that eventual deformation of the new design would also occur as the result of normal operation of HTLTR, but at a reduced rate. Therefore, a surveillance tool capable of detecting deformations as small as 0.010-inches in the VSR poison plates was devised and installed on the VSR system in HTLTR. The surveillance device, the procedure to follow, and the action to take in the surveillance program to insure that a hazardous condition is not permitted to develop in the VSR system in HTLTR are described. (auth)

24959 (HEDL-TME-72-15) PROPOSAL TO IRRADIATE UNENCAPSULATED FUEL PINS IN THE EBR-II: SUBASSEMBLY NUMEC-E. Ballard, E. O.; Metcalf, I. L. (Hanford Engineering Development Lab., Richland, Wash.). Jan 1972. Contract AT-(45-1)-2170. 50p. Dep. NTIS.

The NUMEC-E, 61 pin subassembly will be irradiated in EBR-II support of the FFTF Driver Fuel Development Program. The sixty-one fuel pins are mixed oxide and are clad with 0.230-inch diameter, twenty percent, cold-worked 316 stainless steel. This subassembly is to be reorificed to provide cladding operating temperatures in the range necessary to support the proposed 1100°F bulk coolant outlet temperature operation of FTR. The fuel pin parameters are representative of the proposed FTR fuel pin design. The pins, presently at EBR-II, will be reassembled into a reorificed MK-B-61A subassembly at EBR-II. 16 references. (auth)

24960 (NYO-841-25) HARVARD AIR CLEANING LABORATORY SEMIANNUAL PROGRESS REPORT, MARCH 1, 1971–AUGUST 31, 1971. First, M. W.; Underhill, D. W.; Tadmor, J.; Hall, R. R.; Ratney, R. S.; Baldwin, T. W.; Moeller, D. W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Nov 1971. Contract AT(30-1)-841. 42p. Dep. NTIS.

Studies of sodium aerosol generation and particle removal which simulate conditions to be encountered in the closed loop cells of the FFTF continued. Sodium aerosols generated from molten sodium pools in atmospheres containing 1–2% O_2 had a mean size between 0.8 and 1.5 μm and were not greatly different in size and size distribution from aerosol particles formed in atmospheres containing zero and 21% O_2. Closed loop cells of the FFTF require continuous cooling to remove heat transmitted to the gaseous atmosphere from the machinery and pipes handling molten sodium at temperatures in excess of 1000°F. Plans call for the use of conventional finned-coil coolers. In the event of a sodium release into the closed loop cell, sodium deposition on the cooling coil surfaces may reduce the heat transfer rate drastically, plug the coil so as to completely stop gas flow, and produce destructive corrosion of the cooling coil. One countermeasure is to provide a filter upstream of the cooling coil to remove sodium particles before they reach the coil. Deposition studies were conducted on a commercial ventilation-type filter and a finned coil cooler. Serious plugging problems occurred after short periods of service with both devices. Studies of FFTF cover gas cleaning systems for removal and holdup of radiokrypton and -xenon on activated gas adsorption charcoals continued. These studies of adsorption coefficients were extended to pressures up to 10 atmospheres and temperatures down to -160°C using one of the charcoals found to be superior at atmospheric conditions. The adsorption coefficient for krypton in argon carrier gas increased steadily with decreasing temperature. Adsorption of krypton at 37.5°C from argon and helium carrier gases showed a steady increase in coefficient as pressure increased. At 10 atmospheres, the coefficient was more than twice as great for helium as for argon. (auth)

24961 (RDT-E-6-33-T(11-71)) CONTROL ROD ASSEMBLY. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Nov 1971. 11p. RSO.

Technical requirements, quality assurance provisions, and delivery preparation requirements are presented for FFTF control rod assemblies. (H.D.R.)

24962 (UJV-2527-R) POSSIBLE INCREASE IN OUTPUT OF A MTR FUEL ASSEMBLY. Mantlik, F. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jan 1971. 16p. (In Czech). INIS.

A program is briefly described, written in the GIER-ALGOL code, for computing the output of a materials testing reactor fuel assembly. The results of computation are presented for 16 variants aimed at determining the feasibility of increasing the output of the fuel assembly. The coolant flow rate and outlet temperature were the variable parameters; the hydraulic pressure drop, the maximum can temperature, and the maximum thermal flux on the surface were the limiting conditions. The variations of all these parameters with the heat output of the fuel assembly and the coolant outlet temperature in the active part of the channel are shown in graphs. (INIS)

24963 TEST AND RESEARCH REACTOR EXCURSION RADIATION DETECTION SYSTEM USING AN ON-LINE COMPUTER. Leonard, B. E.; Pfeiffer, W. F.; Hughes, D. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Nucl. Instrum. Methods; 98: No. 3, 501-7(1972).

A pulse reactor radiation detection system is described. The system uses an on-line Scientific Data Systems (SDS) 920 computer, coupled through an analog to digital converting interface, to record and retain the response data for various radiation detectors. Results of typical measurements are presented. An overall range of sensitivity of 10^6 is possible with a precision to within about 5% (exclusive of the detectors) for determining relative reactor power, neutron and gamma ray flux densities (if the spectra remain constant), and neutron and gamma ray tissue kerma rates or the time integral of these quantities. This range

is achieved using combinations of radiation sensors. 13 references. (auth)

24964 KEMA SUSPENSION TEST REACTOR. III. SOME HYDRODYNAMIC ASPECTS OF AN AQUEOUS HOMOGENEOUS SUSPENSION REACTOR. Steenkist, R. (N. V. KEMA, Arnhem, Netherlands). Ingenieur (Utrecht); 83: W131-4(17 Dec 1971). (In Dutch).

For a two-phase flow of liquid and suspended particles the fluid flow has to be limited on both sides (maximum and minimum respectively) in order to avoid erosion of the system and, conversely, settling of particles in a horizontal pipe. Centrifugal forces may cause demixing of the suspension. At some places in a suspension reactor system settling or demixing cannot be avoided. Here special mechanical devices are used. As a consequence the flow pattern is changed, resulting for instance in a quite complicated pattern in the reactor core. Experiments were carried out to determine this flow pattern. The results are used in transient calculations. (auth) (Netherlands)

24965 PROCEDURE FOR MEASURING THE PRESSURE IN THE EXPERIMENTAL CHANNEL OF A REACTOR LOOP DURING OPERATION. Aujollet, Jean-Marie; Pellissier, Henri; Sionnet, Jean; Vere, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,067,644. 26 Jul 1971. Filed 12 Nov 1969. (In French).

A procedure for measuring pressures in the experimental channels of a reactor loop is described. The process consists of attaching electric strain gages to the outside of the tube defining the channel and coating them with at least one layer of a refractory oxide using the Schoop process. Strain measurements obtained from these gages enable estimations to be made of the pressure in the experimental channel, the pressure and the recorded strain being linked by a given law. The gages are mounted in a bridge circuit. In this way high sensitivity and temperature compensation are obtained. (France)

Operation and Economics

24966 (DOCKET-50184-38) NATIONAL BUREAU OF STANDARDS REACTOR. Technical Specifications, Change 4. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Mar 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the surveillance tests schedules. (D.C.C.)

24967 (DOCKET-50184-39) NATIONAL BUREAU OF STANDARDS REACTOR. Action Taken to Correct Item of Noncompliance Described in Letter of January 21, 1972. (Division of Compliance (AEC), Newark, N. J. Region I). 3 Mar 1972. 5p. Dep. NTIS.

Additional information is presented concerning the required inspection intervals for the safety system channels. (D.C.C.)

24968 (DOCKET-50231-113) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Decommissioning Plan and Technical Specifications, Proposed Change 10. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 10 Mar 1972. 85p. Dep. NTIS.

24969 (DOCKET-50231-115) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Eleventh Quarterly Plant Operation Report, November 1, 1971-January 31, 1972. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 23 Mar 1972. 28p. Dep. NTIS.

24970 (ORNL-TM-3745) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT: OCTOBER, NOVEMBER, AND DECEMBER 1971. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). 3 Mar 1972. 24p. Dep. NTIS.

The reactor operated only 82.7% of the time which reduced the operating time for the year to 91.7%. Excessive downtime was caused by the injection of a small amount of demineralizer resin into the primary coolant system. Extensive cleaning, filtering, purging, and flushing operations were required before all system coolant flows returned to normal. As part of an in-service surveillance program, 3 of the original 44 reactor vessel top head studs and nuts were removed for examination. Because of small, incipient cracks found on some of the nuts and studs, the replacement program for these components was accelerated. Basic operating data for the quarter are listed. (auth)

24971 (ORNL-TM-3748) BULK SHIELDING FACILITY QUARTERLY REPORT, OCTOBER-DECEMBER 1971. Tabor, W. H.; Hurt III, S. S.; Lance, E. D. (Oak Ridge National Lab., Tenn.). 10 Mar 1972. Contract W-7405-eng-26. 43p. Dep. NTIS.

The BSR operated at an average power level of 1,880 kW for 58.4% of the time during October, November, and December. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were no unscheduled shutdowns during the quarter. The BSR operated at low power during this quarter for 87 hrs as a training aid for 14 trainees from the TVA Sequoyah nuclear power reactor. The PCA operation during the quarter is summarized. (auth)

Safety and Siting

Refer also to abstract 22912.

24972 (DOCKET-50231-114) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Changes to Proposed Change 10. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 22 Mar 1972. 31p. Dep. NTIS.

Revised technical specifications are presented concerning the shutdown conditions for the reactor. (D.C.C.)

24973 (KFK-1451) CONTAINER DESIGN FOR THE DEUTERIUM SYSTEM OF THE COLD NEUTRON SOURCE IN THE HIGH FLUX REACTOR AT GRENOBLE WHEN TAKING IN ACCOUNT THE EXPLOSION OF A STOCHIOMETRIC DEUTERIUM-AIR MIXTURE. Harig, H. D.; Reutler, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Jul 1971. 21p. (In German). Dep. NTIS (U. S. Sales Only).

The detonation of a stoichiometric deuterium-air mixture at atmospheric pressure has been supposed as the maximum accident in the container system. The consequences of such an explosion are calculated for two containers belonging to this system, one of Zircaloy and the other of stainless steel. An empirically established formula from explosion experiments with TNT is used. Second, the movement of the container wall, based on given peaks and developments of detonation pressures, is calculated. The possible pressure peaks of the reflected shock waves and their effect on surrounding materials are calculated. The result shows that a container being designed for the simple detonation pressure must not burst, even if the pressure of the reflected shock waves is several times higher than the design pressure. (12 references) (auth)

24974 (TID-6934) COMPARISON OF PREDICTED AND MEASURED EFFLUENT BEHAVIOR AND SUMMARY OF ACT DOSE CALCULATIONS. VanVleck, L. D.; Lofthouse, J. H.; O'Brien, R. B. (General Electric Co., Idaho Falls, Idaho, Aircraft Nuclear Propulsion Dept.). 15 Nov 1960. Contract AT-(11-1)-171. 39p. (XDC-60-11-711). Dep. NTIS.

Declassified 20 Oct 1971.

The experience in a number of reactor-insert tests at the ANP Idaho site with respect to the agreement between the predicted and measured behavior of radioactive effluent in the environment is summarized. The measured data of interest in the determination of the radiation dose to downwind areas are included. Dose predictions are presented for the ACT operating 800 hours per year at the FET as well as for the localized melting accident. It is concluded that operation of the ACT can be carried out as proposed without exceeding permissible dose limits. (auth)

24975 (TID-23926) HAZARDS SUMMARY FOR THE PROPOSED LOS ALAMOS OMEGA WEST REACTOR. Jurney, E. T. (Los Alamos Scientific Lab., N. Mex.). 9 Feb 1954. 68p. (P-2-39). Dep. NTIS.

Declassified 19 Oct 1971.

Design parameters for the Los Alamos Omega West Reactor are presented. Analysis of potential hazards related to reactor operations is included. 11 references. (D.C.C.)

24976 SCATTERING OF SLOW NEUTRONS. Schmatz, W.; Stiller, H. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 13: No. 12, 525-7(Dec 1971). (In German and English).

A cold neutron source is used to moderate reactor neutrons down to very low energies. These slow neutrons are used in irradiation experiments for studies of atomic structures and atomic dynamics in condensed matter. (auth)

24977 PLANNING AND DEVELOPMENT OF THE COLD NEUTRON SOURCE AT THE REACTOR FRJ-2. Doose, C. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 13: No. 12, 528-33(Dec 1971). (In German and English).

The considerations which led to the particular layout of the cold neutron source at the reactor FRJ-2 are discussed. The imposed stringent safety requirements in respect of an oxy-hydrogen explosion resulted in the provision of a helium barrier between the hydrogen system and the outer air. The overall engineering concept resulting from the layout of the cold source and from the imposed safety stipulations is described. (auth)

24978 THERMODYNAMIC DESIGN OF THE COLD NEUTRON SOURCE AT THE REACTOR FRJ-2. Stelzer, F. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 13: No. 12, 534-9(Dec 1971). (In German and English).

The thermal design of the cold neutron source was based on the requirement of being able to liquefy, and to maintain in the liquid state in steady operation, a specified quantity of hydrogen near the core of the reactor FRJ-2 without exceeding a specified cryogenic capacity. The most favorable design concept was determined by comparing various possible alternative designs, and the operating performance was calculated. (auth)

24979 CONSTRUCTION AND OPERATION OF THE COLD NEUTRON SOURCE AT THE REACTOR FRJ-2. Doose, C.; Tholen, A. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 13: No. 12, 539-49(Dec 1971). (In German and English).

The thermodynamic, safety engineering and other design requirements resulting from the overall conception of the cold neutron source at the reactor FRJ-2 are described. The main features described are the thermosiphon system, used for the first time for a cold source, the helium barrier and the hydrogen safety system in general, and the supply facilities. The gain factor for a neutron wavelength of 0,5 nm is 10, and that for 1,2 nm is 25. (auth)

24980 INSTRUMENTATION OF THE COLD NEUTRON SOURCE AT THE REACTOR FRJ-2. Preussner, A. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 13: No. 12, 550-2(Dec 1971). (In German and English).

The development of the instrumentation system for the cold neutron source is described, starting from the fault analysis for the system and the acquisition and logic processing of operation and safety parameters. The power supply for the entire facility and the availability of the reactor are also discussed. (auth)

24981 TEMPERATURE MEASUREMENTS IN THE COLD NEUTRON SOURCE AT THE REACTOR FRJ-2. Koeppe, W.; Leyers, H. J. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 13: No. 12, 553-6(Dec 1971). (In German and English).

A brief review of the temperature measurements at the cold neutron source is presented. Following a brief discussion of the irradiation effects, the data logging facility used in the out-of-pile tests is described. (auth)

24982 SAFETY EFFECTS OF LIGHT WATER INFILTRATION IN THE ARGONNE RESEARCH REACTOR (CP-5). Kelber, Charles N. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 47: No. 1, 127-31(Jan 1972).

In the course of the rehabilitation of CP-5, a study was made of the safety problems associated with in-leakage of light water into the primary coolant (heavy water) stream from a tube rupture in the main heat exchanger. The reactivity effects of the light water can be represented by a prompt positive coefficient and a delayed negative coefficient during normal operation. When the rods are pulled out (as during recovery from xenon poisoning), the effects of light water are to decrease the reactivity. The plant is designed to render water in-leakage highly unlikely. Even in the case such in-leakage occurs, the plant protection system is capable of protecting the system against rupture of many tubes in rapid succession. (auth)

24983 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Descamps, Jean-Marie (to Commissariat a l'-Energie Atomique). British Patent 1,254,098. 17 Nov 1971. Priority date 12 Sep 1969, France.

RADIATION TARGET CANS—design characteristics of hydraulic positioned, for swimming pool research reactors
REACTOR EXPERIMENTAL FACILITIES—design characteristics of hydraulic positioned radiation target cans, for swimming pool research reactors
REACTORS, RESEARCH—experimental facilities for swimming pool, design characteristics of hydraulic positioned radiation target cans
REACTORS, SWIMMING-POOL—experimental facilities for research, design characteristics of hydraulic positioned radiation target cans, (D.C.C.)

24984 RECONSTRUCTION OF DRY EXPERIMENTAL CHANNELS FOR THE IRT-TM REACTOR. Gusarov, O. F.; Karnaukhov, V. V.; Leus, V. K. At. Energ. (USSR); 32: No. 1, 60-2(Jan 1972). (In Russian).

During the course of 1½ years a gradual conversion to curved vertical experimental channels was effected, which now makes it possible to load and unload the channels at any desired power level of the reactor IRT-TM. The curved channels are equipped with shielding plugs in their upper ends. The advantages claimed include decreased loading/unloading time and decreased neutron background. (K.S.W.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 22715, 22720, 23214, 23219, 23245, 23247, 23254, 23289, 23359, 23366, and 23391.

24985 (BARC/I-123) WATER CHEMISTRY STUDIES. VI. ROLE OF INORGANIC ION EXCHANGE IN THE PURIFICATION OF REACTOR COOLANT WATER. Venkataramani, B.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 23p. INIS.

The need for maintaining the purity of coolant water for the safe operation of water cooled reactors is stressed. Methods for limiting the allowable total solid content, dissolved oxygen and chloride ion concentrations, maximum conductance, pH etc. are discussed. To remove electrolytes and control pH most economically, demineralization by ion exchange was found desirable. Ion exchange properties of clay minerals and the closely related compounds, mica and vermiculite, some synthetic exchangers such as ammonium molybdosulphate, ferrocyanide molybdate, ferrocyanide tungstate, and inorganic compounds having complex anions were reviewed and it was found that these minerals are not very suitable as ion exchangers. Synthetic inorganic ion exchange materials such as zirconium phosphate, zirconium oxide, titanium and tantalum oxides and magnetite which show excellent promise for high temperature and pressure applications are favored as suitable ion exchangers in the purification of reactor coolant water. (INIS)

24986 (BARC/I-129) ANALYSIS OF ALKALI METAL COOLANTS. Periaswami, G.; Mathews, C. K. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 43p. INIS.

Current techniques for impurity monitoring in coolant sodium were reviewed primarily to assess the developmental effort that may be required in setting up facilities for the analysis of radioactive sodium from coolant loops, at the Reactor Research Center, Kalpakkam. Various laboratory and in-stream techniques for the analysis of impurities such as oxygen, hydrogen, nitrogen, and carbon in parts per million concentration are described. The adaptation of these techniques for the analysis of highly radioactive sodium in the coolant loops of the fast reactor at Kalpakkam is discussed. The need to develop methods for remote operation of highly radioactive sodium is stressed. Areas requiring additional research and development are pointed out. (INIS)

24987 (CEA-CONF-1791) ADAPTATION OF NUCLEAR INSTRUMENTATION TO COMPUTER CONTROL. Douet, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 26p. (In French). (CONF-710340-1). Dep. NTIS (U. S. Sales Only).

From IAEA working group on operation and instrumentation of nuclear power plants; Vienna, Austria (15 Mar 1971).

The results of studies on the adaptation of nuclear instrumentation for control by numerical computer are reported. The simulation, on a hybrid computer, of the neutron control of a nuclear reactor whose essential functions will be supplied by a numerical computer is described. A method of measurement of the power and period during all the dynamics of a reactor by means of an ensemble of detectors managed by a small computer is described. (tr-auth)

24988 (ORNL-tr-2577) ULTIMATE PRESSURE TESTS ON PRESTRESSED CONCRETE PRESSURE VESSEL. Kawamata, S.; Hangai, H.; Tsuboi, Y.; Isobata, O.; Otsuki, Y. Translated for Oak Ridge National Lab., Tenn., from Konkurito Janaru; 9: No. 8, 1-16(Aug 1971). 30p. Dep. NTIS.

Ultimate pressure tests were executed on $\frac{1}{40}$th scale models to examine the behavior of prestressed concrete pressure vessels. Three type models were made of gypsum concrete and micro concrete in pairs which had been developed newly for the miniature model test, and prestressed by using PC rods and wire. In tests, the model was loaded by water pressure to the ultimate state after several load cycles. Although models were broken in different modes, progressive failure and ductility to the pressure loading were recognized in every model. 24 references. (auth)

24989 (ZJE-113) AN APPROACH TO FRACTURE-SAFE DESIGN, MANUFACTURE AND OPERATION OF PRESSURE VESSELS. Kalna, K.; Stepanek, S. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). [1970]. 19p. (CONF-710534-1). Dep. NTIS (U. S. Sales Only).

From Conference on practical application of fracture mechanics to pressure vessel technology; London, England (3 May 1971).

Brittle failure of pressure vessels can arise during construction owing to the effect of residual stresses, at the hydrostatic

pressure test, or during operation. To evaluate the possibility of pressure vessel failure the fracture analysis diagram of the vessel material must be known. A method of designing such a diagram is presented. Some experimental results necessary to determine the material's resistance to brittle fracture are included. Diagrams for two typical pressure vessel conditions, i.e. after welding and at the beginning of service, are presented. According to these diagrams, and on the bases of the vessel stress state and size of flaws detected in the material, the safe conditions for the vessel loading can always be found. (9 references) (auth)

24990 METHOD AND APPARATUS FOR CONTROLLING THERMAL NUCLEAR REACTORS. Power, John L. (to National Aeronautics and Space Administration). U. S. Patent 3,624,241. 30 Nov 1971. Filed 10 Feb 1970.

A power control system for a thermal nuclear reactor utilizes core tubes containing a solid sorbent, a thermal neutron absorbing material in ionic form, and a circulating aqueous solution. Control of the reactor is achieved by regulating the amount and distribution of the ionic poison retained by the solid sorbent in the core tubes. The amount of poison retained by the solid sorbent is regulated by controlling the chemical composition of the circulating solution. This regulation may be assisted by altering the chemical properties of the solid sorbent while the reactor is operating. (Official Gazette)

24991 NUCLEAR REACTOR AND THERMIONIC CONVERTER CELLS THEREFOR. Hobson, Robert R.; Griffin, Thomas E. (to United States Atomic Energy Commission). U. S. Patent 3,623,947. 30 Nov 1971. Filed 22 Jun 1965.

A nuclear thermionic converter has a vertical stack of annular or ring-shaped nuclear fuel members. Within the ring-shaped members is reflector material. Thermionic diodes are mounted on the periphery of the fuel rings, with the emitters being in contact with the fuel. The collectors are filled with moderating material and the reactor is cooled by heat radiation. (Official Gazette)

24992 REACTOR TUBE END CLOSURE. Wright, James R. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,629,069. 21 Dec 1971. Filed 22 Sep 1969.

A reactor tube end closure, comprising a cup-shaped closure body having a chamfered edge for engagement with a tapered surface on the inside of a reactor tube is described. A rotatable threaded spindle secured in the body has an internally threaded collar on it which carries a plurality of outwardly urged, spring-loaded struts. The struts form a collet assembly with each strut having a pad on its outer end for engagement in a recess in the reactor tube. By rotating a serrated wheel on the spindle in one direction the struts can be retracted to disengage the closure from the reactor tube, or by rotating in the other direction urge the seal faces into contact to form a leaktight seal. (Official Gazette)

24993 MEASURING DEVICE, PARTICULARLY APPLICABLE TO CYLINDRICAL OBJECTS. Revert, Philippe (to Commissariat a l'Energie Atomique). French Patent 2,067,527. 26 Jul 1971. Filed 6 Nov 1969. (In French).

An apparatus for measuring the dimensions of objects, particularly cylindrical objects, is described. An example is the nuclear fuel pellets (uranium oxide, Pu) used in the fuel elements of fast neutron reactors. A precise automatic measurement is possible either with single samples, or a series of samples, whose dimensions must be rapidly verified after manufacture. (France)

24994 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Craston, John Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,259,832. 12 Jan 1972. Filed 16 May 1968.

Reference is made to heat exchangers having separate primary and secondary fluid passages, and in particular to such heat exchangers in which the fluid flow passages are subject to changes in fluid pressure. If thin plates are employed for the passages, buckling is liable to occur; on the other hand the use of thick plates increases weight and cost and lowers efficiency. In the systems described anticlastic plates are employed, that is plates having surfaces curved convexly in a longitudinal plane and concavely in a perpendicular plane; examples of such shapes being hyperbolic paraboloids, helicoids, and hyperboloids of revolution. Application of the principle to a reactor fuel element is mentioned. (UK)

24995 GASEOUS CONTROL SYSTEM FOR NUCLEAR REACTORS. Lantz, Edward; Davison, Harry W. (to National Aeronautics and Space Administration). U. S. Patent 3,629,068. 21 Dec 1971. Filed 8 Aug 1968.

A system for controlling the reactivity of a nuclear reactor by varying the amount of a neutron-absorbing gas located inside the reactor is described. (Official Gazette)

24996 FLUID CONTROL AND SAFETY RODS FOR NUCLEAR REACTORS. Agazzi, Alberto; Broggi, Armando; Olona, Induno; de Paratesi, Sergio Galli; Ghiurghi, Luciano (to EURATOM). U. S. Patent 3,629,059. 21 Dec 1971. Priority date 5 Apr 1968, Belgium.

A combined safety and control system for a nuclear reactor is described, comprising tubes passing upwardly through the core of the reactor, a neutron absorbing gaseous atmosphere in the tubes, and means for introducing a liquid neutron poison solution into the tubes in an emergency. The pressure of the gaseous atmosphere is varied to control the power of the reactor. (Official Gazette)

24997 FUEL ASSEMBLY FOR NUCLEAR REACTORS AND HELICAL SPACERS HAVE BUNDLES OF FUEL PINS. Andersson, Herbert Olof; Ekwall, Per Anders (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,629,066. 21 Dec 1971. Priority date 4 Sep 1967, Sweden.

A fuel assembly for nuclear reactors is formed of a polygonal sheathing tube and a bundle of fuel pins inside the tube. The pins are provided with helically wound spacer elements of equal pitch. The fuel pins are of two different types, pins of type B having one more spacer element than those of type A. Each pin of type A is surrounded by six pins of type B, and each fuel pin of type B, except those at the sides of the bundle, is surrounded by alternate pins of types A and B. (Official Gazette)

24998 FLUID-COOLED NUCLEAR REACTORS. Wolff, Paul Heinz Walter (to British Nuclear Design and Construction Ltd.). British Patent 1,265,314. 1 Mar 1972. Filed 5 Mar 1968.

Reference is made to fluid-cooled reactors of the type having a graphite moderator core. In such reactors the moderator is usually built up from parallel columns of moderator material and these columns may undergo bowing owing to differential irradiation growth. In the system described at least an intermediate portion of each column is formed so that in cross section this portion provides at least six equi-spaced radially extending faces, and the surface of the column circumferentially intermediate the faces is so shaped that the faces may engage cooperating faces of adjacent columns. Means are provided to maintain the cooperating faces in engagement; this means may conveniently comprise torque applying means associated with each column. The columns may be built up from individual blocks, in which case those blocks forming the length of each column between its bottom and the intermediate portion are non-rotatably connected together. Each column may be withdrawn completely from the core and from the reactor through a standpipe; the arrangements for withdrawal are described. The torque applying means may comprise ratchet type teeth or keys and keyways. Crab means may be provided to separate the blocks during lifting so as to provide flexibility to the column as it is withdrawn. (UK)

24999 FLUID-COOLED NUCLEAR REACTORS. Walker, Alexander; Williams, Michael Roger Lloyd (to British Nuclear Design and Construction Ltd.). British Patent 1,266,138. 8 Mar 1972. Filed 8 Apr 1968.

Reference is made to fluid-cooled reactors of the type having a solid moderator core enclosed within a pressure vessel, the core being in the form of columns held together by peripheral restraint means between core and pressure vessel. In the arrangement described a baffle is provided between the core and the restraint to provide a passage through which coolant can be fed to maintain the restraint at a lower temperature than the core when the reactor is operating. The arrangement is such that, on reactor shut-down, the restraint and the columns will contract radially at a different rate, the restraint thereby becoming slack and releasing the columns so as to permit them to be renewed through a standpipe. The columns are preferably butted together at their ends in lattice formation and clearance provided to allow for any bowing that may occur. (UK)

25000 FLUID-COOLED NUCLEAR REACTORS. Williams, Michael Roger Lloyd (to British Nuclear Design and Construction Ltd.). British Patent 1,266,139. 8 Mar 1972. Filed 9 Apr 1968.

Reference is made to fluid-cooled reactors of the type employing a solid moderator core. In such reactors the core is housed within a pressure vessel and built up from graphite columns arranged in a lattice pattern. These columns are held together by a circumferential support structure, and under irradiation conditions bowing may occur. In the arrangement described intermediate portions of the columns have a number of curved peripheral faces, the actual number being dependent on the geometry of the lattice formation selected. The peripheral faces of each column are of progressively increasing radius, and means are provided for applying a torque to the above-mentioned intermediate portions of the columns, the arrangement being such that each peripheral face is loaded into engagement with a corresponding face of an adjacent column by the torque applying means, and if, under vary-

ing irradiation conditions, dimensional changes occur, these changes are catered for by appropriate relative rotation of the columns so that the co-operating faces remain in engagement. Each column may be withdrawn completely through a suitable standpipe. The torque applying means may comprise ratchet-type teeth provided on the bottom of each column and on the column support. (UK)

25001 DETECTION OF RAPID ELECTRICAL CONDUCTIVITY FLUCTUATIONS IN HIGH TEMPERATURE LIQUID METALS. Hughes, G. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). J. Phys., E (London); 5: No. 4, 349-52(Apr 1972).

An eddy current probe was developed to measure fluctuations in the electrical conductivity of liquid metals at temperatures up to 600°C. The device was primarily developed for the measurement of thermal noise caused by the mixing of coolant channels of slightly different temperatures, the changes in temperature of the coolant causing a proportional change in its electrical conductivity. The device can detect a percentage change in electrical conductivity of 8×10^{-3} which corresponds to a temperature change of 0.06°C on 600°C for sodium. The response time is limited by the drive frequency employed and for a nominal drive frequency of 10 kHz fluctuations up to a frequency of 1 kHz can be observed. A robust probe construction was achieved using multicore stainless steel sheathed mineral insulated cable to form the probe coil. Primary compensation for resistance changes in the winding caused by the temperature coefficient of the wire is obtained within the probe. Secondary compensation is obtained with an analogue two component bridge system. This compensates for long term drift only (<0.1 Hz) and maintains a bridge balance of less than 1 part in 10^6 over an ambient temperature range of the probe of 200°C. (auth) (UK)

25002 NUCLEAR REACTOR FUEL ELEMENTS. Aston, Michael Desmond; Simpkin, Sidney David (to British Nuclear Design and Construction Ltd.). British Patent 1,265,478. 1 Mar 1972. Filed 28 Mar 1968.

A fuel element assembly is described that comprises a number of layers of fuel pins stacked one upon another and located within a sleeve of moderator material. Each pin has a longitudinal rib for engagement with a rib on an adjacent pin. The pins are held in spaced relation and against relative rotation, one or both end faces of each pin having a bearing surface offset from the pin axis and the layers of pins being located within the sleeve so that alternate layers have their bearing surfaces at 180° to one another, the bearing surfaces of any one layer being offset in the same direction, whereby the layers tend to provide columns of pins in zig-zag formation. Each pin may have a bore, in which case the bores of each column of pins are aligned to provide a coolant passage, the spaces between adjacent columns providing additional coolant passages. The pins of each layer may be arranged in a hexagonal lattice around a central tube, each pin being provided with six equi-spaced ribs, one rib of pins adjacent the central tube or the sleeve wall engaging the respective tube or wall. Packing pieces may be provided, and a separate sleeve may be provided for each layer of pins. The assembly may be built up layer by layer on a support plate whereby it may be lifted by the plate via a tie rod. (UK)

25003 SOLID NEUTRON-MODERATING CORE STRUCTURES FOR NUCLEAR REACTORS. Pettinger, Donald Stanley (to Nuclear Power Group Ltd.). U. S. Patent 3,632,472. 4 Jan 1972. Priority date 17 Mar 1969, Great Britain.

A core structure for a nuclear reactor comprises an assembly of blocks of neutron-moderating material arranged in vertical columns, wherein the opposed faces of adjacent blocks in at least some of the columns are so shaped that one opposed face can roll over the other and such that when the blocks are assembled in the column, the lines or areas of contact are displaced from a vertical plane or planes through the centers of gravity of the blocks of the column whereby overturning moments are exerted on the blocks causing them to lean in mutually supporting relationship on blocks in adjacent columns. (Official Gazette)

25004 REACTOR FUEL LEAK DETECTION. Rubin, Bernard F.; Larson, Charles L.; Grossman, Leonard N. (to General Electric Co.). U. S. Patent 3,632,470. 4 Jan 1972. Filed 15 May 1968.

A method of detecting ruptured fuel element cladding in nuclear reactors which permit radioactive material to leak therefrom is disclosed. Varying proportions of two stable isotopes of an inert indicating gas are added to the inert filler gas in fuel elements. Each subassembly or group of fuel elements contains a specific individual combination of the gases. Mass spectrometric analysis of the reactor cover gas or off-gas will detect the indicating gas and determine the isotopic ratio thereof to indicate which subassembly contains a leaking fuel element. (Official Gazette)

Reactor Physics and Core Engineering

Refer also to abstract 22721.

Physics

Refer also to abstracts 22821 and 24951.

25005 (ANL-7712) ARC SYSTEM STANDARD PATHS AND CATALOGUED PROCEDURES. Woodruff, W. L.; Daly, T. A.; Henryson II, H.; Kier, P. H.; Regis, J. P.; Stenberg, C. G.; Toppel, B. J. (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 260p. Dep. NTIS.

A discussion and documentation of the ARC System standard paths and catalogued procedures available for production usage are presented. The intent of the discussion is to serve as an aid to the user in running production problems. The discussion of each of the standard paths and catalogued procedures includes a brief description of the capabilities provided, listings of the path and procedure, a listing of the BCD user input data sets that may be required, and sample problems which demonstrate some of the capabilities and options available. The general discussion provided may serve as a guide to those who might wish to write other paths to provide some special capability. 19 references. (auth)

25006 (ARH-600(Vol.1)(Rev.1)) CRITICALITY HANDBOOK. VOLUME I. Carter, R. D.; Kiel, G. R.; Ridgway, K. R. (Atlantic Richfield Hanford Co., Richland, Wash). 28 Jun 1968. Contract AT(45-1)-2130. 135p. Dep. NTIS.

Guides are presented for the safe processing, transportation, and storage of fissionable materials. Administrative policies and procedures covering lines of responsibility, criticality prevention criteria, and emergency conditions are described. Fundamental engineering data useful in criticality safety are presented. (H.D.R.)

25007 (ARH-600(Vol.2)(Rev.1)) CRITICALITY HANDBOOK. VOLUME II. Carter, R. D.; Kiel, G. R.; Ridgway, K. R. (Atlantic Richfield Hanford Co., Richland, Wash.). 23 May 1969. Contract AT(45-1)-2130. 167p. Dep. NTIS.

Criticality safety data are presented for homogeneous systems containing plutonium and for homogeneous systems containing ^{235}U. (H.D.R.)

25008 (BNWL-1601) MEASUREMENT OF K_∞ AS A FUNCTION OF TEMPERATURE FOR A $^{233}UO_2-^{232}ThO_2-C$ LATTICE. Oakes, T. J. (Battelle Pacific Northwest Labs., Richland, Wash.). Feb 1972. Contract AT(45-1)-1830. 35p. Dep. NTIS.

The parameters for the experiment with an HTGR type fuel were selected so as to minimize the Δk_∞ as a function of temperature. Experimentally, the results indicate that the desired effect was achieved, i.e., the k_∞ of the $^{233}UO_2-ThO_2-C$ fuel chosen exhibited no change within error over the temperature range being investigated. However, a value of $\Delta k_\infty = -0.0324$ over the range from 20°C to 1000°C was obtained via the calculational method. 12 references. (auth)

25009 (BNWL-1637) COMPARISON OF ALTERNATE NONDESTRUCTIVE TECHNIQUES FOR THE DETERMINATION OF ^{238}U REACTION RATE RATIOS. Oden, Dale Robert Jr. (Battelle Pacific Northwest Labs., Richland, Wash.). Jan 1972. Contract AT(45-1)-1830. 96p. Dep. NTIS.

The generally large disagreement which exists between measured and calculated values of ρ^{28} (the ratio of epicadmium to subcadmium neutron capture in ^{238}U), as well as that between measured values using different experimental techniques, suggests the possible presence of systematic experimental errors in these measurements. In order to determine if systematic biases due to the mode of counting are present, three counting techniques for the determination of ^{239}Np disintegration rates were compared in the measurement of ^{238}U reaction rate ratios in a water moderated lattice of UO_2 rods. Depleted uranium foils, irradiated bare and cadmium covered in the fuel rod, were counted alternately on a NaI singles spectrometer, a NaI-NaI coincidence system, and via a technique employing a 20 cc Ge(Li) singles spectrometer. Although the three counting methods yielded the same cadmium ratio results within experimental uncertainties (±1%) (indicating the absence of a systematic bias due to the mode of counting) comparisons on the basis of several other criteria indicated the NaI-NaI coincidence method to be the best overall. In addition, values of ρ^{28} obtained from the direct measurement of the ^{238}U cadmium ratio were compared to those obtained from the thermal activation technique to determine the perturbation due to the presence of cadmium in the lattice. Measured values were also compared to calculated values from two analytical models. The effect of fuel spacers inside the cadmium box, used in the

fuel rod for the prevention of epicadmium neutron streaming from the moderator through the cadmium buttons and into the foils, was also measured. (71 references) (auth)

25010 (INR–1266) STUDIES OF EPITHERMAL CELL PARAMETERS IN THE REACTOR LATTICES WITH MULTITUBE ENRICHED FUEL. Josefowicz, E. T. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 20p. INIS.

The methods of measurement of epithermal cell parameters epithermal-to-thermal fission ratio and resonance-to-thermal absorption ratio in ^{238}U, in reactor lattices with multitude enriched fuel are described. The interpretation of the experimental results in the frames of infinite multiplication factor is shown and, the simple methods of calculation of resonance escape probabilities in ^{235}U and ^{238}U with collision probability considerations taken into account in the cells with complicated structure are presented. The results for few types of lattices are given and discussed: water moderated (WWR-SM normal and diluted), graphite and water moderated (ANNA with water), graphite moderated (ANNA without water) and beryllium and water moderated lattice (MR type). (auth) (INIS)

25011 (JAERI–1219) PEACO: A CODE FOR CALCULATION OF GROUP CONSTANTS OF RESONANCE ENERGY REGION IN HETEROGENEOUS SYSTEMS. Ishiguro, Yukio; Takano, Hideki (Japan Atomic Energy Research Inst., Tokyo). 28 Jun 1971. 57p. Dep. NTIS (U. S. Sales Only).

A code was developed for calculating effective group constants of resonance energy region in various heterogeneous systems. This code was made by taking characteristic merits of the codes constructed for the computation of resonance integral. Heterogeneity is treated by a collision probability method in which the first-collision probabilities are computed by a linear interpolation of the values previously prepared. An energy interval under consideration is divided into extremely narrow meshes on which the neutron slowing-down equation is solved using a recurrence formula for the slowing down source. Resonance cross sections are read-in from library tapes corresponding to different temperature of the composition including resonant materials. The code is written in FACOM-230/60 FORTRAN which is a standard type commonly used. Important information is stored in variable dimensions determined beforehand by input data. Hence, for practical purpose, there is no special limitation on input data, unless total variable dimensions necessary for a calculation do not exceed 34,000. (30 references) (auth)

25012 (RT/FI–(71)24) IMPLEMENTATION AND OPERATION OF THE DAMASCUS CODE ON THE ROME UNIVERSITY UNIVAC 1108. Mango, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 7 Sep 1971. 159p. Dep. NTIS (U. S. Sales Only).

The light water reactor physics code DAMASCUS was written at Battelle Northwest Laboratory. The code has been operated on the UNIVAC 1108 of the University of Rome, and a working document which should facilitate the operation of the code in the actual version is presented. (auth)

25013 (RT/FI–(71)35) SPACE-DEPENDENCE AND ASYMPTOTIC BEHAVIOUR OF DIFFUSION COEFFICIENT, BUCKLING, AND FLUX IN NEUTRON TRANSPORT THEORY. Premuda, F.; Trombetti, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 28 Oct 1971. 31p. Dep. NTIS (U. S. Sales Only).

The spatial dependence of diffusion coefficient, D, and buckling, B, in plane and spherical geometry has been evaluated in the framework of monoenergetic transport theory with isotropic scattering. The asymptotic behaviors of D and B near the interfaces and boundaries have been determined from the correspondent asymptotic behavior of the neutron flux and current. The angular dependence of the neutron flux at the interfaces and boundaries has also been determined. (10 references) (auth)

25014 TEORIYA GETEROGENNOGO REAKTORA. (Theory of the Heterogeneous Reactor). Galanin, A. D. Moscow; Atomizdat (1971). 248p.

The theory of the thermal neutron heterogeneous reactor is treated, where each unit of fuel is considered a neutron source and a neutron sink. The basic concept of this theory, for the case of small units, was formulated by Soviet theoreticians in 1945–1947. The theory is extended to large blocks. The general theory is applied to the calculation of the diffusion length and the moderation of neutrons in directions parallel and perpendicular to the reactor channels. The coefficients of polarization of blocks are described with reference to their effect on the migration path as a function of fuel blocks. 41 references. (K.S.W.)

25015 ADVANCES IN NUCLEAR SCIENCE AND TECHNOLOGY. VOLUME 5, 1969. Henley, Ernest J.; Lewins, Jeffery (eds.). New York; Academic Press, Inc. (1969). 392p. $21.00.

Included are 6 papers on various engineering and theoretical aspects of nuclear reactor systems. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 24766, 24923, 24950, and 25016–25018.

25016 STABILITY ANALYSIS OF NONLINEAR SPACE DEPENDENT REACTOR KINETICS. Kastenberg, William E. (Univ. of California, Los Angeles). Advan. Nucl. Sci. Technol.; 5: 51-93(1969).

Four methods of examining the stability problem for distributed parameter system are presented. The temperature effects on multiplication, space–time reactor kinetics equations, and simplifications for various feedback models are reviewed. A general in-depth discussion of the Lyapunov, semi-group theory, comparison functions, and maximum principle mathematical techniques is given. Recent applications of these techniques for systems of interest are reviewed, and some simple examples are described. (60 references) (H.D.R.)

25017 VARIATIONAL METHODS IN NUCLEAR ENGINEERING. Kaplan, S. (Univ. of Southern California, Los Angeles). Advan. Nucl. Sci. Technol.; 5: 185-221(1969).

Some of the developments of variational methods in nuclear engineering are reviewed, with the emphasis on those growing out of the concepts of canonical and involuntary transformations. Alternate ways of arriving at the same results using nonvariational methods are discussed. (36 references) (H.D.R.)

25018 ROUND-OFF FREE SOLUTION OF THE BOLTZMANN TRANSPORT EQUATION IN SLAB GEOMETRY. Lois, Lambros (Bettis Atomic Power Lab., West Mifflin, Pa.); Certaine, J. Contract AT(11-1)-GEN-14. Advan. Nucl. Sci. Technol.; 5: 325-68 (1969).

Some analytic solutions of the Boltzmann transport equation contain round-off errors which may render a solution useless. The most frequently employed methods for solution of the transport problem are surveyed, and an example is given of an analytic solution that fails because of round-off errors. A new analytic solution that is free of round-off is described, and some results obtained with this method are presented. (43 references) (H.D.R.)

25019 ASPECTS IN THE USE OF THE INVERSE NEUTRON KINETICS TECHNIQUE. Anselmi, L.; Hage, W.; Hettinger, H.; Hohmann, H.; Kumpf, S. (EURATOM-CCR, Ispra, Italy). Nucl. Instrum. Methods; 98: No. 3, 485-91(1972).

Sources of error arising in the analysis of rapidly and slowly varied reactivities using the inverse neutron kinetics technique are discussed and demonstrated by experiments. 16 references. (auth)

25020 VARIETY AND HIERARCHY OF DATA EXTRACTION METHODS IN NUCLEAR REACTOR NOISE ANALYSIS. Baers, B. (Helsinski Univ. of Tech., Otaniemi, Finland). Nucl. Instrum. Methods; 98: No. 3, 493-9(1972).

A review and systematic approach to the data extraction problem in nuclear reactor noise analysis are presented. A large number of signal representations and data extraction methods are obtained by using expansions of the fundamental joint probability and related quantities into sets of observable quantities and by using natural classification criteria specifying the experimental conditions. Most of the previously used and suggested techniques are members of this set. A large number of alternate or modified techniques can be suggested some of which may be of practical interest. The hierarchy of representations presented also indicates that the application of information theory to noise problems may be useful and powerful approach. 37 references. (auth)

25021 COMPUTER CODE KSPACE FOR SPACE TIME REACTOR KINETICS. Saito, Kazuya; Ebizuka, Yoshie (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 102, 45-54(Mar 1971).

A computer code KSPACE for solving one dimensional multigroup (maximum six) time dependent diffusion equation by means of a finite difference method was developed in order to study space and energy distribution of neutron flux of fast reactors during transients. The code found discrete numerical approximation to the multigroup diffusion equation with proper boundary and initial conditions. Difference equations with respect to space mesh points and current time steps were derived. Difference techniques used were a modified central difference method for the space meshes and Crank–Nicholson method for the time steps. The code is capable of calculation for slab, cylindrical or spherical geometry which consists of one or more regions. Maximum allowable number of regions is 10, and maximum number of total mesh points including origin is 101. Some examples are shown. Accuracy of

the calculated results depended directly on the time step interval, the space mesh interval and other factors. (Japan)

25022 SUBOPTIMAL CONTROL OF A STOCHASTIC DISTRIBUTED-PARAMETER NUCLEAR REACTOR SYSTEM. Kuroda, Yoshiteru; Makino, Akira (Tokai Univ., Tokyo). Tokai Daigaku Kiyo Kogakubu; 1971: No. 2, 1-8(Nov 1971). (In Japanese).

The suboptimal tracking problem of a distributed-parameter nuclear reactor system under stochastic environment is described. The state of the system considered is also contaminated by observation noise. The optimal estimator of the state is obtained from the output, i.e., measurement data of the neutron flux distribution by using the distributed Kalman–Bucy filter. The optimal control input is then derived by use of a quadratic cost functional which is the mean of the weighted sum of the system error and control action. Optimization technique is based on the Bellman's principle of optimality. A simple example is presented concerning a one-group infinite slab reactor with a couple of control rods. (auth) (Japan)

25023 CONCEPT OF MULTIPLE-INPUT ZERO POWER DESCRIBING FUNCTIONS IN NUCLEAR REACTORS. Akcasu, A. Z.; Bost, C. M. Jr. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng.; 47: No. 1, 104-15(Jan 1972).

The concept of multiple-input zero power describing functions is introduced in terms of the nonlinear response of a zero power reactor to a large periodic reactivity input, and the dual-input zero power describing function is calculated explicitly. The effect of amplitude and phase of the second input on the describing function is investigated numerically. The zero power describing function is used to construct the describing function at high power using closed loop feedback circuit theory. This approach allows nonlinear effects and feedback effects to be discussed separately. The nonlinear stability of a two-temperature reactor is investigated using the high power describing function and Nyquist stability criterion with particular attention to the existence and stability of limit cycles. In addition, the discrepancies between various definitions of the describing function are discussed and clarified. (12 references) (auth)

25024 EXPONENTIAL AND NON-EXPONENTIAL NEUTRON FIELD DECAYS IN GRAPHITE. Huels, M. (Inst. for Reactor Development, Juelich, Ger.). J. Nucl. Energy; 25: No. 11, 533-50(Nov 1971).

Neutron pulse experiments were performed on 28 graphite assemblies with bucklings in the range 23.4×10^{-4} cm^{-2} to 139×10^{-4} cm^{-2}. The decay curves were measured from immediately after the initial pulse to nearly 8 msec after the pulse. These curves can be described by an exponential for $B^2 < 61.72 \times 10^{-4}$ cm^{-2}, while for greater bucklings, deviations from exponential time behavior are observed at initially 6 msec after the pulse injection. With increasing buckling the departure from exponential tends earlier and earlier to decrease the instantaneous decay constant $\alpha_{eff}(t)$. The point where the α_{eff} vs B^2 curve splits with time is fairly well found with the simple approximation of De Saussure (1962) when calculating not with the experimentally found inelastic scattering cross-section at the Bragg peak (1.89 MeV) but with the one given by Parks model. Reasons why the non-exponential neutron field decays occur at bucklings where other authors report clean exponentials are discussed. Diffusion parameters are given only for that buckling range where no deviations from exponential time behavior are found, i.e., up to $B^2 = 61.72 \times 10^{-4}$ cm^{-2}. The best fit, for graphite of density 1.6 g cm^{-3}, yields $D_0 = (2.164 \pm 0.023) \times 10^5$ cm^2 sec^{-1} and $C = (42.936 \pm 2.420) \times 10^5$ cm^4 sec^{-1}, in numerical agreement with other recent investigations which, however, found their results in a much larger bucklings range. (auth) (UK)

25025 CONJUGATE EQUATIONS OF REACTOR KINETICS WITH DELAYED NEUTRONS. Orlov, V. V. At. Energ. (USSR); 32: No. 1, 57-8(Jan 1972). (In Russian).

An extension of the importance theory of neutrons in the nonstationary and nonhomogeneous problem was previously accomplished without allowing for delayed neutrons. The theory is further amplified giving consideration to delayed neutrons. (K.S.W.)

25026 TRANSPORT THEORY CALCULATION OF NEUTRON FLUX, DISADVANTAGE FACTORS, AND EFFECTIVE DIFFUSION COEFFICIENTS IN SQUARE CELLS AND SLABS. Williams, M. M. R.; Wood, J. (London Univ.). J. Nucl. Energy; 26: No. 3, 141-62(Mar 1972).

An exact transport theory calculation was carried out on a finite reactor lattice, and analytical results obtained for the flux distribution, disadvantage factor and anisotropy of diffusion. Spatially constant cross-sections were assumed but a periodic source simulated accurately the cell flux that would arise in a more realistic situation. Exact results for the disadvantage factor showed clearly the errors involved in cylindricalization; in particular, the minimum in the disadvantage factor vs. moderator/fuel ratio curve was shown to exist and not to be a consequence of the reflecting boundary condition. However, the minimum occurred at much lower moderator/fuel ratios than those considered by previous workers and certainly much lower than predicted by the reflecting boundary, cylindricalized cell approximation. Curves of the fluxes in the cell, together with the distortions arising from leakage, are given as well as detailed tables of numerical values of the disadvantage and streaming factors. These tables are offered as benchmark results against which approximate techniques may be compared. (auth) (UK)

Core Thermal Hydraulics

Refer also to abstract 24755.

25027 HEAT TRANSFER AND FLUID FLOW IN POROUS FUEL ELEMENTS AND THERMAL SHIELDS. El-Wakil, M. M.; Choudhury, W. U.; Marr, W. W. (Univ. of Wisconsin, Madison). Nucl. Eng. Des.; 17: No. 3, 329-40(1971).

The heat-transfer and fluid-flow problem in porous nuclear fuel elements and thermal shields is investigated. Porous fuel elements of flat-plate and hollow-cylindrical types are compared to conventional surface-cooled non-porous fuel elements. The comparison shows that porous elements result in much lower fuel temperatures for the same specific power or much higher specific powers for the same temperatures. The study also indicates that porous materials subjected to radiation operate at much lower temperatures and temperature gradients than non-porous materials when used as thermal shields. (12 references) (auth)

25028 HOT CHANNEL FACTOR AS DETERMINED BY THE PERMISSIBLE NUMBER OF HOT CHANNELS IN THE CORE. Arnsberger, P. L. (Westinghouse Electric Corp., Madison, Pa.); Mazumdar, M. Nucl. Sci. Eng.; 47: No. 1, 140-9(Jan 1972).

In thermal hydraulic design of nuclear reactor cores it is of interest to know the probability of 0, 1, 2, ... D hot channels and/or cladding and fuel hot spots [i.e., channels (spots) in the core at which temperature limits are exceeded]. Furthermore, it might even be advantageous to design a core for a maximum permissible number of such hot channels (spots) by comparing the safety considerations with the plant efficiency. Numerical procedures available in the open literature using statistical methods are restricted to the evaluation of hot channel or hot spot factors corresponding to the requirement that either the most exposed nominal channel (spot) or all channels (spots) in the entire core do not exceed imposed temperature or heat flux limits. A method, referred to as "Method of Correlated Temperatures," which enables an evaluation to be made of the entire probability distribution of the number of hot channels as a function of the corresponding hot channel factor is described. A quantitative comparison is performed between the proposed method and other procedures by applying the different methods to a hot channel factor analysis of a simplified hypothetical LMFBR-type core. (22 references) (auth)

25029 HEAT TRANSFER CRISIS DATA WITH STEAM–WATER MIXTURE IN A SIXTEEN ROD BUNDLE. Evangelisti, R. (CSN-CNEN, Casaccia, Italy); Gaspari, G. P.; Rubiera, L.; Vanoli, G. Int. J. Heat Mass Transfer; 15: No. 3, 387-402(Mar 1972).

The experimental data obtained under the PELCO program on heat transfer crisis (54 point) with vertical upward flow of boiling water in a sixteen rod square bundle are presented. The experiments were carried out with the CISE IETI-3 heat transfer facility under the following conditions: geometry: square array of sixteen rods, 1.51 cm dia, 270 cm overall heated length; radial power distribution: uniform; axial power distribution: two steps ($\phi_{upstream} = 2\phi_{downstream}$; $L_{upstream} = 104$ cm), specific mass flowrate: 70-160 g/cm^{2}s (seven values); subcooled water at inlet: (5-75°C subcooling); test section average pressure: 69 kg/cm^2 abs.; a brief description of the test element design and of the experimental plant is given. A short discussion of critical power results and a comparison with the predictions of some of the available correlations are also reported. (auth) (UK)

GENERAL

Civilian Defense

Refer also to abstract 22748.

Law

25030 (LA-4891) TWO-DIMENSIONAL SEARCH AND INTERPOLATION ON A DISTORTED RECTANGULAR GRID. PROGRAM SIϕG2D. Jameson, Robert A.; Mills, Rene S. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 6p. Dep. NTIS.

A program to restore data from a known, but distorted, rectangular grid to a true grid is presented. The mathematics behind the program and a FORTRAN IV listing are given. (3 figures) (R.W.R.)

25031 (NP-19197) ANNUAL REPORT, 1970. (National Inst. of Radiation Protection, Stockholm (Sweden)). 1971. 130p. (In Swedish). Dep. NTIS (U. S. Sales Only).

An account is given of the activities of the National Institute of Radiation Protection in Sweden in 1970. Included is statistical information in 27 tables with headings in English. (G.N.) (Sweden)

25032 (NRL-AR-21) ANNUAL REPORT FOR THE YEAR 1970. (National Radiation Lab., Christchurch (New Zealand)). 38p. Dep. NTIS (U. S. Sales Only).

Radiation protection activities of the National Radiation Laboratory, New Zealand, during 1970 are reported. A list of technical and staff training publications during the period is included. (C.H.)

25033 COMPUTERS IN RADIOLOGY. Proceedings of the International Meeting, Brussels, September 17–20, 1969. De Haene, R.; Wambersie, A. (eds.). Supplement the Journal Belge de Radiologie. Basel; S. Karger AG (1970). 673p. (In several languages). (CONF-690953).

Ninety-seven papers discuss various uses of computers for data analysis for radiotherapy and radiodiagnostic procedures. Topics discussed include computer calculations of therapeutic radiation doses for beam and implant sources; the radiation dose to various tissues from interstitially administered radioisotopes; the use of computers for analysis of radioisotope scan and scintigraphic data; and the use of computers for the compilation of data on patients. (C.H.)

25034 EXPERIENCES OF POLICE CONTROL OF RADIOACTIVE MATERIALS. Ecsedi, K. (Beluegyminiszterium, Budapest). Izotoptechnika; 14: No. 11, 542-7(Nov 1971). (In Hungarian).

Experiences gathered by the Ministry of the Interior during police control of the production, sale, and use of radioactive materials are discussed. (auth)

25035 PREPARAZIONE E FORMAZIONE DELGI ESPERTI IN CAMPO NUCLEARE. Atti del XV Congreso Nucleare di Roma, 12–13 Marzo 1970. (Preparation and Training of Experts in the Nuclear Field. Proceedings of the 15th Nuclear Congress of Rome, March 12–13, 1970). Serie Simposi. Rome; Comitato Nazionale Energia Nucleare (1971). 239p. (In Italian and Engiish) (CONF-700344).

Basic and advanced training of nuclear chemists, nuclear engineers, technicians, operating personnel, and supervisory individuals is discussed by representatives of government and industry. The content and scope of special courses which lead to employment in the nuclear energy are outlined. Typical personnel requirements for a boiling water reactor and a suggested organization chart are described. (K.S.W.)

Miscellaneous

25036 (ACRH-1000-303) SOME MOLECULAR ASPECTS OF RED CELL DIFFERENTIATION. Goldwasser, Eugene (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Biochemistry). [1971]. Contract AT(11-1)-69. 12p. (CONF-711043-1). Dep. NTIS.

From International conference on erythropoiesis; Capri, Italy (13 Oct 1971).

25037 (ACRH-1000-304) PURIFICATION AND PROPERTIES OF ERYTHROPOIETIN. Goldwasser, Eugene; Kung, Charles K.-H. (Argonne Cancer Research Hospital, Chicago, Ill.). [1971]. 14p. (CONF-711043-2). Dep. NTIS.

From International conference on erythropoiesis; Capri, Italy (13 Oct 1971).

25038 (AERE-R-6799) MODIFIED MARQUARDT SUBROUTINE FOR NON-LINEAR LEAST SQUARES. Fletcher, R. (Atomic Energy Research Establishment, Harwell (England)). May 1971. 25p. Dep. NTIS (U. S. Sales Only). UK 20 pence.

25039 (ANL-7863) LITHIUM/CHALCOGEN SECONDARY CELLS FOR COMPONENTS IN ELECTRIC VEHICULAR-PROPULSION GENERATING SYSTEMS. Interim Technical Summary Report No. 4, November 23, 1970–May 22, 1971. Gay, E. C.; Arntzen, J. D.; Cairns, E. J.; Kincinas, J. E.; Riha, J. G.; Trevorrow, L. E.; Walsh, W. J.; Webster, D. S. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 54p. Dep. NTIS.

25040 (BNWL-SA-1776(Suppl.)) SALINITY REDUCTIONS RESULTING FROM FREEZING SEAWATER IN POLYETHYLENE BOTTLES. Robertson, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. Contract AT(45-1)-1830. 6p. Dep. NTIS.

25041 (CEA-CONF-1817) DETERMINATION OF MAJOR ELEMENTS IN ROCKS BY EXCITATION IN LUMINESCENT DISCHARGE. Ropert, M.-E. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 10p. (In French). (CONF-711015-1). Dep. NTIS (U. S. Sales Only).

From sixteenth international conference on spectroscopy; Heidelberg, Germany (4 Oct 1971).

25042 (CEA-N-1503) ANISN SYSTEM: REPORT NO. 3, ANISEX PROGRAM, REPROCESSING OF AN ANISN OUTPUT TAPE. Dupont, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 13p. (In French). Dep. NTIS (U. S. Sales Only).

25043 (CEA-R-4261) FRESH WATER FROM SALT WATER USING THE SUCCESSIVE EXPANSION METHOD. Agostini, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1972. 59p. (In French). Dep. NTIS (U. S. Sales Only).

25044 (CEA-R-4278) SECONDARY HARDENING IN Fe–C SYSTEMS AND IN SOFT AND WEAKLY ALLOYED STEELS. Milasin-Zivkovic, Nada (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 184p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

25045 (CONF-710835-1) NATURE OF HUMORAL IMMUNOLOGIC DEFICIENCIES OF THE AGED. Perkins, E. H.; Makinodan, T. (Oak Ridge National Lab., Tenn.). [1971]. 40p. Dep. NTIS.

From first Rocky Mountain symposium on aging; Fort Collins, Colo. (26 Aug 1971).

25046 (COO-1469-200) FAILURE TOLERANT FILING SYSTEM. Whaley, Alfred D. (Illinois Univ., Urbana. Dept. of Computer Science). Feb 1972. Contract AT(11-1)-1469. 15p. (UIUCDCS-R-72-506). Dep. NTIS.

25047 (COO-1629-26) PHONON RESONANT SCATTERING IN CdS CONTAINING Co^{2+}. Chau, Cheuk-Kin (Illinois Inst. of Tech., Chicago. Dept. of Physics). [1970]. 20p. Dep. NTIS.

25048 (COO-1629-27) MAGNETO-THERMAL PROPERTIES OF HEAT TRANSPORT IN COBALT CHLORIDE THIOUREA. Ni, C.; Spector, H. N.; Weinstock, H. (Illinois Inst. of Tech., Chicago. Dept. of Physics). [nd]. Contract AT(11-1)-1629. 30p. Dep. NTIS.

25049 (COO-1794-10) STRENGTHENING AND TOUGHENING OF BRITTLE MATERIALS. Progress Report. Broutman, L. J.; Agarwal, B. D.; Mallick, P. K. (Illinois Inst. of Tech., Chicago). 31 Jan 1972. Contract AT(11-1)-1794. 67p. Dep. NTIS.

25050 (COO-2034-7) ANALYTICAL STUDY ON DISLOCATIONS IN THIN FILMS. Final Report. Mura, T. (Northwestern Univ., [Evanston], Ill.). [1972]. Contract AT(11-1)-2034. 4p. Dep. NTIS.

25051 (COO-3151-140) HYDROSTATIC PRESSURE BEHAVIOR OF THE EXCHANGE FIELDS IN MnF_2:Fe^{2+}. Johnson, K. C.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jan 1972. 12p. Dep. NTIS.

25052 (CTC-53) AUTOMATIC DATA PROCESSING OF DOCUMENT ACCOUNTABILITY: OAK RIDGE GASEOUS DIFFUSION PLANT. Jones, J. G.; Yount, S. L.; Green, R. O. Jr. (Union

Carbide Corp., Oak Ridge, Tenn. Computing Technology Center); Myers, W. C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 6 Mar 1972. Contract W-7405-eng-26. 93p. Dep. NTIS.

25053 (EUR-4777) NEW ALGORITHM TO MINIMIZE FUNCTIONS. van der Voort, E.; Dorpema, B. (European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). 1972. 32p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 50.-.

25054 (GAT-T-1705) TRANSIENT STABILITY CORRELATION FOR LARGE INDUCTION MOTOR LOAD SYSTEMS USING INFINITE BUS TECHNIQUES. Harley, Charles F. (Goodyear Atomic Corp., Piketon, Ohio). Jun 1971. Contract AT(33-2)-1. 69p. Dep. NTIS.

Thesis. Submitted to Ohio Univ., Athens.

25055 (GAT-T-1749) DEVELOPMENT OF A SYSTEM TO MAKE QUANTITATIVE MEASUREMENTS WITH THE ELECTRON MICROPROBE. Boyd, David E. (Goodyear Atomic Corp., Piketon, Ohio). 28 Aug 1971. Contract AT(33-1)-1. 103p. Dep. NTIS.

Thesis. Submitted to Univ. of Ohio, Athens.

25056 (IA-1236) ANALYSIS OF THE LIMITATIONS OF OUTGASSING RATE MEASUREMENTS BY THE VARIABLE CONDUCTANCE METHOD. Berman, A.; Hausman, I.; Roth, A. (Israel Atomic Energy Commission, Tel Aviv). Oct 1971. 34p. Dep. NTIS (U. S. Sales Only).

25057 (IA-1242) SPECTROCHEMICAL DETERMINATION OF IMPURITIES IN METALLIC PURE AND HIGH PURITY ZINC. Schoenfeld, I.; Steiner, M. (Israel Atomic Energy Commission, Tel Aviv). Oct 1971. 19p. Dep. NTIS (U. S. Sales Only).

25058 (IA-1249) NUMERICAL EVALUATION OF HERMITE POLYNOMIALS AND THEIR INTEGRALS. Gur, Y. (Israel Atomic Energy Commission, Tel Aviv). Oct 1971. 36p. Dep. NTIS (U. S. Sales Only).

25059 (IJS-R-598) INFLUENCE OF VANADIUM PENTAFLUORIDE, CHROMIUM PENTAFLUORIDE, AND MANGANESE TRIFLUORIDE ON THE REACTION BETWEEN XENON AND FLUORINE. Slivnik, J.; Zemva, B. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jun 1971. 13p. Dep. NTIS (U. S. Sales Only).

25060 (IJS-R-603) HYDRAZINIUM FLUORONIOBATES(V). Frlec, B.; Bertoncelj, M. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Sep 1971. 14p. Dep. NTIS (U. S. Sales Only).

25061 (IJS-R-604) DETERMINATION OF CRITICAL CONSTANTS AND ESTIMATION OF SOME PHYSICAL PROPERTIES OF XENON FLUORIDES AT HIGHER TEMPERATURES. Ogrin, T. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Sep 1971. 9p. Dep. NTIS (U. S. Sales Only).

25062 (INFCIRC-152(Mod.1)) TEXT OF A SAFEGUARDS TRANSFER AGREEMENT RELATING TO A BILATERAL AGREEMENT BETWEEN AUSTRIA AND THE UNITED STATES OF AMERICA. (International Atomic Energy Agency, Vienna (Austria)). 19 Nov 1971. 3p.

25063 (INFCIRC-155) TEXT OF THE AGREEMENT BETWEEN FINLAND AND THE AGENCY FOR THE APPLICATION OF SAFEGUARDS IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS. (International Atomic Energy Agency, Vienna (Austria)). 27 Oct 1971. 29p.

25064 (INFCIRC-156) TEXT OF THE AGREEMENT BETWEEN AUSTRIA AND THE AGENCY FOR THE APPLICATION OF SAFEGUARDS IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS. (International Atomic Energy Agency, Vienna (Austria)). 19 Nov 1971. 27p.

25065 (INP-775) MOESSBAUER EFFECT STUDIES OF FERROUS OXIDES $Fe_{1-x}O$. Hrynkiewicz, H. U.; Kulgawczuk, D. S.; Mazanek, E. S.; Pustowka, A. M.; Tomala, K.; Wyderko, M. E. (Institute of Nuclear Physics, Krakow (Poland)). 1971. 10p. Dep. NTIS (U.S. Sales Only).

25066 (INP-780) ATOMIC AND MAGNETIC STRUCTURE OF THE HEUSLER ALLOYS Ni_2MnSb, Ni_2MnSn, Co_2MnSn. Szytula, Andrzej; Kolodziejczyk, A.; Rzany, Henryk; Todorovic, Jugoslav; Wanic, Adam (Institute of Nuclear Physics, Krakow (Poland)). 1971. 19p. Dep. NTIS (U. S. Sales Only).

25067 (IS-2711) CRYSTAL STRUCTURE AND PHYSICAL PROPERTIES OF A TRICLINIC SODIUM TUNGSTEN OXIDE. Frazen, H. F.; Shanks, H. R.; deJong, B. H. W. S. (Ames Lab., Iowa). [1971]. 26p. (CONF-711019-4). Dep. NTIS.

From fifth materials research symposium on solid state chemistry; Gaithersburg, Md. (18 Oct 1971).

25068 (IS-2712) CRYSTAL CHEMISTRY OF METAL-RICH REFRACTORY SULFIDES. Chen, Horng-yih; Franzen, Hugo F. (Ames Lab., Iowa). [1971]. 34p. (CONF-711019-3). Dep. NTIS.

From fifth materials research symposium on solid state chemistry; Gaithersburg, Md. (18 Oct 1971).

25069 (IS-2719) THERMAL EXPANSION COEFFICIENTS FOR ALKALI HALIDES CONTAINING DEFECTS. Case, C. R.; McLean, K. O.; Swenson, C. A.; White, G. K. (Ames Lab., Iowa). [1971]. 5p. (CONF-711033-3). Dep. NTIS.

From third thermal expansion symposium; Corning, N. Y. (27 Oct 1971).

25070 (IS-2770) ELECTRICAL FLAME SPECTROSCOPY. Fassel, Velmer A. (Ames Lab., Iowa). [1970]. 74p. (CONF-711015-2). Dep. NTIS.

From sixteenth international conference on spectroscopy; Heidelberg, Germany (4 Oct 1971).

25071 (IS-2778) PHONON SPECTRA OF fcc ^4He. Traylor, J. G.; Stassis, C.; Reese, R. A.; Sinha, S. K. (Ames Lab., Iowa). [1971]. 10p. (CONF-720304-2; SM-155/A-12). Dep. NTIS.

From fifth IAEA symposium on neutron inelastic scattering; Grenoble, France (6 Mar 1972).

25072 (JINR-E4-6238) EFFECT OF CRYSTAL-FIELD ANISOTROPY ON CURIE TEMPERATURE OF ISING FERROMAGNET. HTS EXPANSION METHOD. Brankov, J. G.; Przystawa, J.; Praveczki, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 13p. Dep. NTIS (U. S. Sales Only).

25073 (KFKI-71-75) TEMPERATURE-DEPENDENT PART OF THE IMPURITY RESISTIVITY IN DILUTE AlCu, AlMn, AND AlCr ALLOYS. Toth, J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [nd]. 10p. Dep. NTIS (U. S. Sales Only).

25074 (LBL-222) ENGINEERING ANALYSIS OF THE ROTORFERMENTOR. Margaritis, Argyrios; Wilke Charles R. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 44p. (CONF-710831-1). Dep. NTIS.

From Annual meeting of the Society for Industrial Microbiology; Fort Collins, Co. (29 Aug 1971).

25075 (LBL-574) DEPENDENCE OF MEDULLARY HEMATOPOIESIS ON CLOSE CONTACT WITH AN ABUNDANCE OF HEALTHY CELLS OF THE ENDOSTEUM. Van Dyke, Donald (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 31p. Dep. NTIS.

25076 (LBL-607) SYSTEMATIC SYNTHESIS OF SEPARATION SCHEMES. Thompson, Roger W.; King, C. Judson (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 29p. (CONF-720205-2). Dep. NTIS.

From Symposium on computer-aided chemical process synthesis; Dallas, Tex. (21 Feb 1972).

25077 (MLM-1868) LOCAL EQUILIBRIUM AND DIFFUSION IN MULTIPHASE COUPLES. Braun, J. D. (Mound Lab., Miamisburg, Ohio). 27 Oct 1971. Contract AT-33-1-GEN-53. 106p. Dep. NTIS.

Thesis. Submitted to Ohio State Univ., Columbus.

25078 (NP-19215) LOW FIELD DEPENDENCE OF SUSCEPTIBILITY MAXIMUM IN ANTIFERROMAGNETIC $MnCl_2.4H_2O$. Note No. 330. Cerdonio, M.; Paroli, P. (Rome Univ. (Italy). Istituto di Fisica). 23 Jul 1971. 7p. Dep. NTIS (U. S. Sales Only).

25079 (NP-19224) DANISH ATOMIC ENERGY COMMISSION, 1970/71. Fifteenth Annual Report. (Atomenergikommissionen, Copenhagen (Denmark)). Nov 1971. 59p. Dep. NTIS (U. S. Sales Only).

Activities of the Danish Atomic Energy Commission and the Risø Research Establishment for the period April 1, 1970 to March 31, 1971 are summarized. The operations of the various facilities at the Research Establishment are revised. Operating staff levels and financial data are tabulated, a selected list of staff publications is given, and the design data on research facilities are presented. (Denmark)

25080 (NRL-7281) FRACTURE-SAFE DESIGN OF ALUMINUM AND TITANIUM ALLOY STRUCTURES. Goode, R. J.; Judy, R. W. Jr. (Naval Research Lab., Washington, D. C.). 3 Nov 1971. 34p.

25081 (ORNL-IBP-71-11) POPSID, A FORTRAN IV PROGRAM FOR DETERMINISTIC POPULATION STUDIES. Dean, Frederick C. (Alaska Univ., College. Dept. of Wildlife Management. Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 42p. Dep. NTIS.

25082 (ORNL-NSF-EP-13) SIMPLE: MULTIVARIATE LINEAR REGRESSION ANALYSIS. Westley, G. W. (Oak Ridge

National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 43p. Dep. NTIS.

25083 (ORNL-TM-3607) ELASTIC BUCKLING OF HEATED, STRAIGHT-LINE PIPING CONFIGURATIONS. Brock, John E. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 66p. Dep. NTIS.

25084 (ORNL-TM-3649) OPTICAL PROPERTIES OF POTASSIUM, RUBIDIUM, AND CESIUM IN THE VACUUM ULTRAVIOLET. Whang, U. S.; Arakawa, E. T.; Callcott, T. A. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 132p. Dep. NTIS.
Thesis. Submitted to Univ. of Tennessee, Knoxville, by U. S. Whang.

25085 (ORNL-TM-3665) OPTICAL PROPERTIES OF LIQUID CCl_4, C_6H_{14}, C_6H_{12}, C_6H_{10}, C_6H_8, AND C_6H_6 IN THE VACUUM ULTRAVIOLET. Sowers, B. L.; Birkhoff, R. D.; Arakawa, E. T. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 100p. Dep. NTIS.
Thesis. Submitted by B. L. Sowers to Univ. of Tennessee, Knoxville.

25086 (ORNL-TM-3697) ORCAL: A CONVERSATIONAL CALCULATING LANGUAGE FOR THE ND-812 COMPUTER. Kelly, Myron T. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 141p. Dep. NTIS.

25087 (ORNL-tr-2552) EXTRACTION OF RARE METALS FROM FLUE DUSTS. Gerlach, J.; Hochgeschwender, K.; Pawlek, F. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Metall; 21: No. 7, 700-8(1967). 31p. Dep. NTIS.

25088 (ORNL-tr-2566) VITAMIN B_{12} REQUIREMENT OF PHOTOTROPHIC SULFUR BACTERIA. Pfennig, N.; Dieter-Lippert, K. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Arch. Mikrobiol.; 55: 245-56(1966). 16p. Dep. NTIS.

25089 (ORO-2575-53) CYTOLOGICAL AND RADIOAUTOGRAPHICAL ANALYSIS OF A COLD-INDUCED MITOTIC BLOCKAGE IN THE NEUROBLASTS OF THE GRASSHOPPER CHORTOPHAGA VIRIDIFASCIATA (DeGeer). Reese, Marshall Edward Jr. (Tennessee Univ., Knoxville). Dec 1970. Contract AT-(40-1)-2575. 49p. Dep. NTIS.
Thesis.

25090 (ORO-4061-4) INTERCHANGE OF ESSENTIAL PROGRAMS BETWEEN DISSIMILAR COMPUTERS. Progress Report, June 1, 1971-May 31, 1972. Feustel, Edward Alvin (Rice Univ., Houston, Tex. Lab. for Computer Science and Engineering). Feb 1972. Contract AT(40-1)-4061. 12p. Dep. NTIS.

25091 (ORO-4075-1) REPRESENTATION OF CREEP OF METALS. Onat, E. Turan; Fardshisheh, F. (Yale Univ., New Haven, Conn. Dept. of Engineering and Applied Science). Dec 1971. Contract AT(40-1)-4075. 153p. Dep. NTIS.

25092 (RFP-1823) RAPID AND RELIABLE METALLOGRAPHIC TECHNIQUE FOR SILVER. Calabra, Arthur E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 23 Feb 1972. Contract AT(29-1)-1106. 10p. Dep. NTIS.
A reliable and rapid metallographic preparation procedure for silver is described. The metallographic sample need only be ground through 600-grit (soft) silicon carbide paper, followed by an electrolytic lap-polish to remove the flowed metal. A chemical etch is then used to resolve the grain structure in fine detail. There are no artifacts or evidence of prior preparation steps, and the true grain structure is achieved in a minimum of time. Emphasis is also made on illustrating the effects that improper metallographic preparation can have on the microstructure. (auth)

25093 (RLO-1750-39) PRELIMINARY CHECKLIST OF SELECTED GROUPS OF INVERTEBRATES FROM OTTER TRAWL AND DREDGE COLLECTIONS OFF OREGON. McCauley, James E. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1968]. 25p. Dep. NTIS.

25094 (RLO-1750-40) PHYSICAL ASPECTS OF THE COLUMBIA ESTUARY. Neal, Victor T. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1963]. 42p. Dep. NTIS.

25095 (RLO-1750-50) SIZE STRUCTURE AND GROWTH RATE OF EUPHAUSIA PACIFICA OFF THE OREGON COAST. Smiles, Michael C. Jr.; Pearcy, William G. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. 23p. Dep. NTIS.

25096 (RLO-1750-51) EFFECTS OF COLUMBIA RIVER DISCHARGE ON CHLOROPHYLL a AND LIGHT ATTENUATION IN THE SEA. Small, Lawrence F.; Curl, Herbert Jr. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1969]. 28p. Dep. NTIS.

25097 (RLO-1750-57) ECOLOGICAL OBSERVATIONS ON THE BENTHIC INVERTEBRATES FROM THE CENTRAL OREGON CONTINENTAL SHELF. Carey, Andrew G. Jr. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. 33p. Dep. NTIS.

25098 (RLO-1750-58) TECHNIQUES FOR SAMPLING BENTHIC ORGANISMS. Carey, Andrew G. Jr. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1968]. 19p. Dep. NTIS.

25099 (RLO-1750-63) GROWTH AND REPRODUCTION OF THE LANTERNFISH STENOBRACHIUS LEUCOPSARUS. Smoker, William; Pearcy, William G. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1968]. 32p. Dep. NTIS.

25100 (RLO-1750-64) GEOGRAPHIC DISTRIBUTION AND RELATIVE ABUNDANCE OF THE SALPIDAE OFF THE OREGON COAST. Hubbard, Lyle T. Jr.; Pearcy, William G. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1969]. 22p. Dep. NTIS.

25101 (RLO-1750-65) SCATTERING LAYERS AND VERTICAL DISTRIBUTION OF OCEANIC ANIMALS OFF OREGON. Pearcy, William G.; Mesecar, Roderick S. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. 17p. Dep. NTIS.

25102 (RLO-1750-67) COMPARISON OF BENTHIC INFAUNAL ABUNDANCE ON TWO ABYSSAL PLAINS IN THE NORTHEAST PACIFIC OCEAN WITH COMMENTS ON DEEP-SEA FOOD SOURCES. Carey, Andrew G. Jr. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1970]. 40p. Dep. NTIS.

25103 (RLO-1750-68) GROWTH OF A SEA URCHIN, ALLOCENTROTUS FRAGILIS, AT DIFFERENT DEPTHS OFF THE OREGON COAST. Sumich, James Larry (Oregon State Univ., Corvallis. Dept. of Oceanography). 19 Aug 1970. 51p. Dep. NTIS.

25104 (RLO-2227-T-12-2) NEW RECORDS FOR FOUR DEEP-SEA SHRIMPS FROM THE NORTHEASTERN PACIFIC. Wasmer, Robert A. (Oregon State Univ., Corvallis. Dept. of Zoology). [1970]. 11p. Dep. NTIS.

25105 (RLO-2227-T-12-15) COMPARATIVE STUDY OF THE INFAUNA OF THE CENTRAL OREGON CONTINENTAL SHELF. Bertrand, Gerard Adrian (Oregon State Univ., Corvallis). Jun 1971. 123p. Dep. NTIS.
Thesis.

25106 (RLO-2227-T-12-23) ESTIMATING PRECISION FOR THE METHOD OF STANDARD ADDITIONS. Larsen, Ingvar L.; Hartmann, Norbert A.; Wagner, Jerome J. (Oregon State Univ., Corvallis). [1971]. 13p. Dep. NTIS.

25107 (RLO-2227-T-12-24) THREE SPECIMENS OF BATHYSAURUS MOLLIS GUNTHER, 1878 FROM THE NORTHEASTERN PACIFIC OCEAN. Stein, David; Butler, John (Oregon State Univ., Corvallis. Dept. of Oceanography). [1966]. 7p. Dep. NTIS.

25108 (RLO-2227-T-12-25) SWIMBLADDER MORPHOLOGY AND BUOYANCY OF MYCTOPHIDS OFF OREGON. Butler, John L.; Pearcy, William G. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1971]. 22p. Dep. NTIS.

25109 (RLO-2228-T-1-4) HIGH-TEMPERATURE OXIDATION OF IRIDIUM. Annual Progress Report No. 2. Wimber, R. T. (Montana State Univ., Bozeman. Dept. of Aerospace and Mechanical Engineering). 25 Feb 1972. Contract AT(45-1)-2228. 25p. Dep. NTIS.

25110 (RLO-2229-T-1-6) SUSPENDED SEDIMENT DISTRIBUTION PATTERNS WITHIN AN ACTIVE TURBID-OUTWASH FIORD. Burrell, David C. (Alaska Univ., College. Inst. of Marine Science). [1971]. Contract AT(45-1)-2229. 19p. Dep. NTIS.

25111 (RLO-2229-T-1-7) SUSPENDED SEDIMENT SIZE FRACTIONATION WITHIN A FIORD-ESTUARY: APPLICATION OF ELECTRONIC COUNTING TECHNIQUES. Burrell, D. C.; Hadley, R. S. (Alaska Univ., College. Inst. of Marine Science). [1971]. 15p. (CONF-711212-1). Dep. NTIS.
From Meeting of the American geophysical union; San Francisco, Calif. (Dec 1971).

25112 (SC-CR-70-6179) DYNASOR II: A FINITE ELEMENT PROGRAM FOR THE DYNAMIC NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION (USER'S MANUAL). Tillerson, Joe R.; Haisler, Walter E. (Texas Agricultural and Mechanical Univ., College Station. Dept. of Aerospace Engineering). Oct 1971. Contract 82-3683. 108p. Dep. NTIS.
For Sandia Labs., Albuquerque, N. Mex.

25113 (SC-DC-714408) COMPUTER-BASED THERMOGRAPHIC DISPLAYS AND REAL-TIME TECHNIQUES. Ballard,

D. W.; Stiefeld, B. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 10p. (CONF-720301-4). Dep. NTIS.
From Spring conference of the American Society for Nondestructive Testing; Los Angeles, Calif. (13 Mar 1972).

25114 (SC-DR-710729) AIR DROPPED SEA ICE PENETROMETER. Young, C. W.; Keck, L. J. (Sandia Labs., Albuquerque, N. Mex.). Dec 1971. 103p. Dep. NTIS.

25115 (SC-R-722645) LIGHTNING AND BALL LIGHTNING: FRONTIERS FOR RESEARCH. Cooper, J. A. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 38p. (CONF-710539-1). Dep. NTIS.
From Electrical engineering and computer science conference; Albuquerque, N. Mex. (18 May 1971).

25116 (SC-RR-710868) TELEMETRY REPORT: HAVE SINEW-1 FLIGHT TEST. Berst, D. W.; Warthen, C. M.; Lloyd, D. A. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 71p. Dep. NTIS.

25117 (SC-T-722472) DISTRIBUTION OF TEMPERATURE AND POPULATION IN RUBY LASER RODS DURING PUMPING. Veduta, A. P. Translated for Sandia Labs., Albuquerque, N. Mex., from Zh. Priki. Spektrosk.; 9: No. 6, 964-8(Dec 1968). 10p. Dep. NTIS.

25118 (SCL-DR-710116) DIGITAL FILTER TECHNIQUES FOR MINICOMPUTERS. Soderstrand, M. A.; Maulden, J. K. (Sandia Labs., Livermore, Calif.). Mar 1972. 88p. Dep. NTIS.

25119 (SGAE-PH-112/1971) EXPERIENCE WITH A COMPUTER PROGRAM FOR RESIDUAL GAS ANALYSERS. Dobrozemsky, R. (Oesterreichische Studiengesellschaft fuer Atomenergie G,m,b,H., Seibersdorf). 1971. 15p. Dep. NTIS (U. S. Sales Only).

25120 (TID-25945) FRACTIONATION OF GUANYLATE OLIGOMERS AND AN APPROACH TO AN ANALYSIS OF CYTOSINE-RICH REGIONS IN DNA. Olson, Ann Campbell (Tennessee Univ., Knoxville). Dec 1971. 85p. Dep. NTIS.
Thesis.

25121 (TID-25949) ROTARY TEMPLATE HOLDER. Dawson, D. O.; Roberts, A. O. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 15 Feb 1972. 2p. Dep. NTIS.

25122 (TID-25953) SOIL BEHAVIOR UNDER EARTHQUAKE LOADING CONDITIONS. (Shannon and Wilson, Inc., Seattle, Wash. Agbabian-Jacobsen Associates, Los Angeles, Calif.). Jan 1972. Contract W-7405-eng-26; Subcontract 3354. 394p. Dep. NTIS.
For Oak Ridge National Lab., Tenn.

25123 (UCRL-73552) SMOKE DEVELOPMENT OF PLASTICS UNDER VARIOUS FIRE PARAMETERS. Gaskill, J. R. (California Univ., Livermore. Lawrence Livermore Lab.). 12 Nov 1971. 25p. (CONF-720502-1). Dep. NTIS.
From thirtieth annual technical conference of the Society of Plastic Engineers; Chicago, Ill. (15 May 1972).

25124 (UR-3490-10) ELECTRON PROBE ANALYSIS OF THE CALCIUM DISTRIBUTION IN CELLS OF THE EMBRYONIC CHICK CHORIOALLANTOIC MEMBRANE. I. A CRITICAL EVALUATION OF TECHNIQUES. Coleman, James R.; Terepka, A. Raymond (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1971]. 32p. Dep. NTIS.

25125 (UR-3490-11) ELECTRON PROBE ANALYSIS OF THE CALCIUM DISTRIBUTION IN CELLS OF THE EMBRYONIC CHICK CHORIOALLANTOIC MEMBRANE. II. DEMONSTRATION OF INTRACELLULAR LOCATION DURING ACTIVE TRANSCELLULAR TRANSPORT. Coleman, James R.; Terepka, A. R. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1971]. 29p. Dep. NTIS.

25126 (UR-3490-25) LOCALIZATION OF AN ^{125}I-LABELED RAT TRANSPLANTATION ANTIBODY IN TUMORS CARRYING THE CORRESPONDING ANTIGEN. Izzo, Mary Jane; Buchsbaum, Donald J.; Bale, William F. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1971]. 11p. Dep. NTIS.

25127 (UR-3490-30) MECHANISM OF INTERACTION BETWEEN Na^+-DEPENDENT TRANSPORT SYSTEMS FOR SUGARS AND AMINO ACIDS. EVIDENCE AGAINST A ROLE FOR THE SODIUM GRADIENT. Randles, Joan; Kimmich, George; Barrett, Gene; Tucker, Anne Marie (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1971]. 9p. Dep. NTIS.

25128 (UR-3490-31) BONE MINERALIZATION IN TISSUE CULTURE: THE CALCIUM-PHOSPHATE PRODUCT AND RATIO. Ramp, W. K.; Neuman, W. F. (North Carolina Univ., Chapel Hill. Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1971]. Contract AT(30-1)-49. 12p. Dep. NTIS.

25129 (UR-3490-33) [DDT AND THE ENVIRONMENT]. Berg, George G. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1970]. 3p. Dep. NTIS.

25130 (UR-3490-34) CRYSTAL STRUCTURE OF POTASSIUM O, O-DIBENZYLPHOSPHORODITHIOATE $KS_2P(O-CH_2-C_6H_5)_2$. Hazel, J. P.; Collin, R. L. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1971]. 27p. Dep. NTIS.

25131 (Y-1809) FLUORINE GAS AS A CLEANING AGENT FOR APOLLO BULK-SAMPLE CONTAINERS. Liddle, R. H.; McIntyre, J. M.; McAlister, C. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 8 Mar 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

UNITED STATES
ATOMIC ENERGY COMMISSION
P. O. BOX 62
OAK RIDGE, TENNESSEE 37830

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U. S. ATOMIC ENERGY COMMISSION

POSTAGE AND FEES PAID
U S GOVERNMENT PRINTING OFFICE

U.S.MAIL

UNIVERSITY MICROFILMS
SERIAL PUBLICATIONS
300 NORTH ZEEB ROAD
ANN ARBOR MICHIGAN 48106

1

Recent USAEC publications of special interest

RADIOACTIVE WASTE PROCESSING AND DISPOSAL [TID-3311(Suppl. 3)]

The 2249 references cited in this bibliography supplement those in TID-3311 and TID-3311(Suppls. 1 and 2). The references were selected from *Nuclear Science Abstracts,* Vol. 21 to issue 4 of Vol. 26 (1967 to February 1972), by a computer search technique and are arranged by volume and abstract number. Corporate and personal author, report number, and subject indexes are included. All literature cited is publicly available.

TITLE LISTING OF CIVILIAN POWER REACTOR DOCKET LITERATURE IN NUCLEAR SCIENCE ABSTRACTS, Volumes 21–25 (1967–1971) (TID-3324)

This bibliography cumulates, in docket number order, 4938 technical documents (announced in *NSA*) submitted to the USAEC in support of U. S. nuclear power reactor license applications. Docket numbers are cross referenced to *NSA* abstract numbers. A subject index is included.

Available from

National Technical Information Service
U. S. Department of Commerce
Springfield, Virginia 22151

TID-3311(Suppl. 3)
Paper, 8½ x 11, 592 pp. $6.00
Microfiche 0.95

TID-3324
Paper, 8½ x 11, 358 pp. $6.00
Microfiche 0.95